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Systems Reference Library

**IBM 9020D System
and
IBM 9020E System
Operator's Manual**

This publication describes the system structure, information format, addressing, programming considerations and operator controlled equipment. Also included are descriptions of controls and indicators, and operating instructions for: System Console, Configuration Console, IBM 2540 Card Read Punch, IBM 1403 Printer Model 2, IBM 1052 Model 7 Printer-Keyboard, IBM 2401 Magnetic Tape Unit, and IBM 2312/2318 Disk Storage Unit. In the descriptions of the IBM 9020 System I/O devices, only those System/360 optional features that have actually been implemented in the IBM 9020 System are mentioned.

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Second Edition (March 1, 1972)

This minor revision of the manual obsoletes the previous edition (A27-2736-0) and incorporates Technical Newsletter GN31-0008, dated July 1, 1971. The revision includes information pertaining to the 2312/2318 Disk Storage Units. In addition, miscellaneous editorial corrections are incorporated.

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INTRODUCTION

The IBM 9020D System and 9020E System are powerful solid-state data processing systems designed to meet the high performance requirements of Air Traffic Control operations. The advanced logical design of the systems, implemented by microminature technology, provides a high degree of flexibility and reliability. The inherent modularity of the basic logic structure enables economical and efficient operation of the systems.

The following introductory discussion is divided into two parts:

IBM 9020D Central Computer Complex
IBM 9020E Display Channel Processor

Each describes the system structure data formats and codes, programming considerations, and operator controlled equipment.

IBM 9020D CENTRAL COMPUTER COMPLEX

SYSTEM CONFIGURATION

The basic elements and units of an IBM 9020D System are:

- IBM 7251-09 Storage Elements
- IBM 7201-02 Computing Elements
- IBM 7231-02 Input/Output Control Elements
- IBM 7289-02 Peripheral Adapter Modules
- IBM 2803-01 Tape Control Units
- IBM 2314-A1 Storage Control Units
- IBM 7265-02 System Console
- Assorted I/O devices attached to and operated through their respective control units (PAM, SCU and TCU)

All 9020D elements are constructed as self contained units, with each having its own power supply. The 9020D Central Computer Complex is shown in Figure 1.

IBM 7251-09 Storage Element

The IBM 7251-09 Storage Element (SE) contains one SE within each physical package. The basic cycle time of the Basic Storage Module (BSM) is 800-ns. Interleaving of Storage accesses is permissible if successive references are to odd and even addresses. Interleaving allows a possible effective basic storage cycle time of 400-ns. This time is limited by the 400-ns cycle time of the storage protect buffer. The SE contains 524,288 bytes, each byte consisting of eight data bits plus one parity bit. Bytes can be accessed by the Storage Element circuits only in groups of eight, called doublewords.

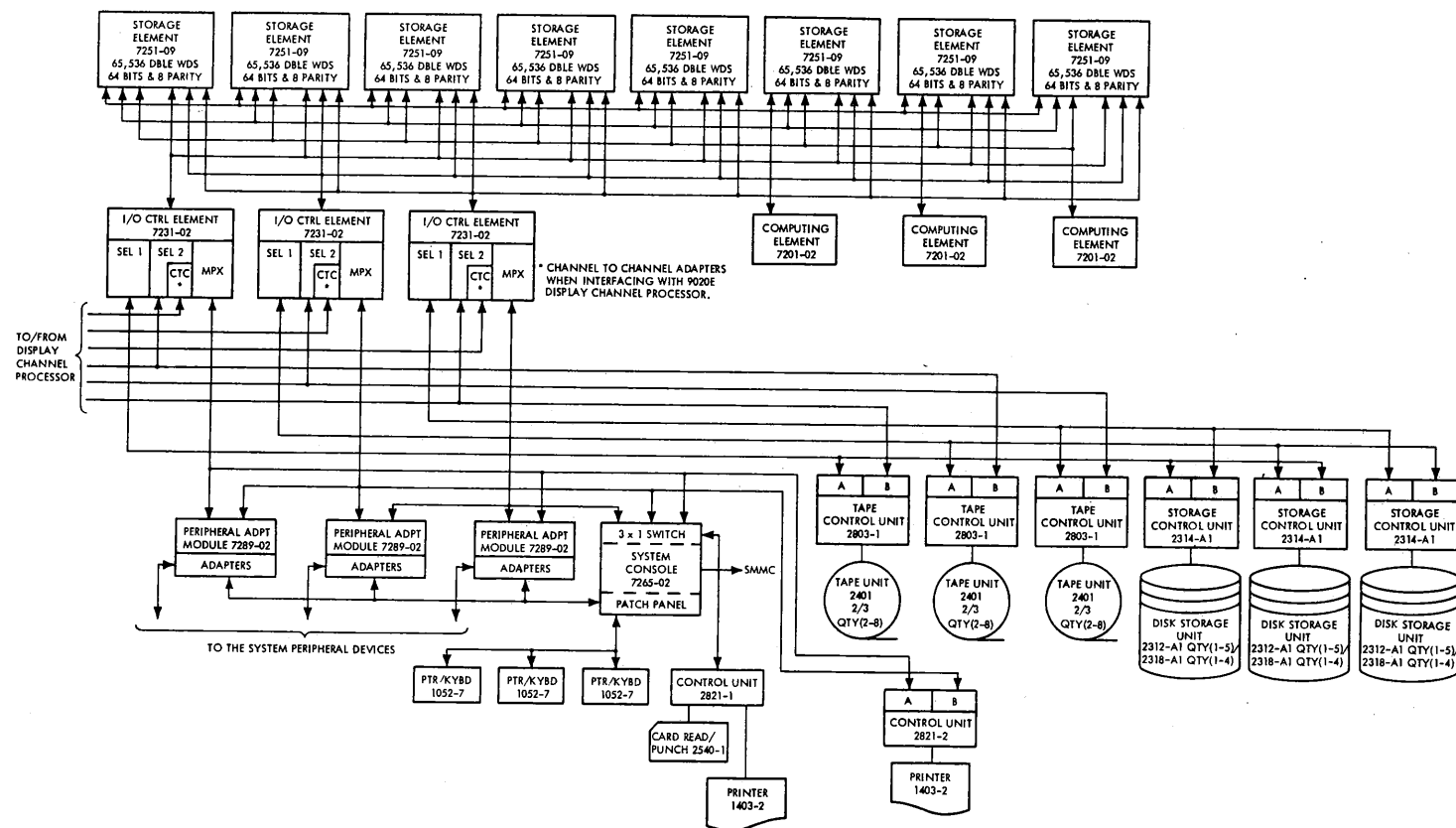


Figure 1. 9020D Central Computer Complex

Individual or multiple bytes within a word can be operated upon or selected by various machine instructions or operations. Each SE contains its own power supply, back-up battery power, and maintenance panel.

Each SE can be accessed from any of four CE's (the fourth CE is an expansion option) and three IOCE's. Honoring of accesses is controlled by a Configuration Control Register and priority circuitry. There is special interface circuitry provided to buffer address and data information during IOCE accesses. This feature allows the 7251-09, during IOCE accesses, to appear in timing and function the same as the 7251-03/04/08. Because the cycle time of the 7251-09 is much faster than required for the IOCE, underlapping of CE cycles with IOCE accesses is permitted.

IBM 7201-02 Computing Element

The IBM 7201-02 Computing Element (CE), is the computational, logical, and control element of both the IBM 9020D, Central Computing Complex (CCC), and the IBM 9020E Display Channel Processor (DCP). As the focal element within both the 9020D and 9020E System, the 7201-02 CE provides the functional duality to establish, organize, and control either multi-element computer system to perform the particular system task. It contains special facilities for inter-element communications and maintenance which enable it to operate effectively in the FAA environment.

As a computing element, the IBM 7201-02 has a wide range of computational, data processing, and system control capabilities. It can operate using fixed or variable-field data. Arithmetic operations are performed with decimal numbers, short or long floating-point numbers, or full or half-word binary numbers. As a CE, the IBM 7201-02 issues input-output instructions to initiate IOCE data transfers to or from I/O devices and to control I/O processor operations.

The CE is organized to process data in 36-bit word form, each word consisting of four bytes of information (byte = eight data bits plus parity bit). Data is stored in or fetched from Storage Elements (0.8 usec cycle) and Display Elements (0.8 usec cycle) on a double-word basis; controls are provided to selectively update a specific byte within a word for byte oriented operations. Although the capability to ultimately address up to 16,777,216 byte locations in storage is achieved by using a 24-bit binary address, the basic CE for the 9020D and 9020E Systems is designed to address locations in 10 (65,536 doublewords) Storage Elements or 5 (65,536 doublewords) Storage Elements and 5 (32,768 doubleword) Display Elements, respectively.

The CE has a basic internal cycle time of 200-ns. It's internal logic contains data registers, interconnecting data paths, and sequence controls. Some of the registers are contained in Local Storage (LS). The 200-ns transistorized high-speed local storage consists of 16 general purpose (32 bits + 4 parity) and 4 double length (64 bits + 8 parity) floating-point, addressable registers. One additional register (32 bits + 4 parity) is provided for temporary storage

during execution of some instructions.

Sequence is accomplished by microprogram commands (microinstructions are linked to form a microprogram. A microprogram controls an entire sequence of cycles forming a complete operation, e.g., the execution of an instruction. The Read Only Storage is not addressable by the standard program instructions (except by the DIAGNOSE instruction).

A CE Control Panel is provided. The main functions of the control panel are to provide the ability to store and display information in storage, in local storage, some registers, part of the program status word (PSW), to allow the operator to reset the system and to perform the Initial Program Load (IPL) sequence.

The controls are divided into a monitor and a maintenance section. The main functions provided in the monitor section are the control and indication of power, the indication of system status operator to machine communication, and initial program loading.

The controls used for operator intervention are the same as those used for maintenance. These controls include resets, store and display functions, control of instruction execution rates, etc. The controls for marginal checking and special tests are normally used for maintenance in State Zero.

The environment external to 7201-02 consists of those elements with which it must communicate. The CE, is capable of exercising various degrees of control and supervision over the major system elements, including other 7201-02 Computing Elements. Two-way communication (control and/or data) interfaces are provided between each 7201-02 CE and each of the elements which it communicates.

IBM 7231-02 Input/Output Control Element

The IBM 7231-02 Input/Output Control Element (IOCE) is a functional element that enables I/O units to be attached to the 9020D/E System. It does this by providing and controlling two selector channels (three selector channels in 9020E System) and a multiplexor channel to which I/O control units can be attached. The IOCE operates in conjunction with 7201-02 Computing Elements (CE) and 7251-09 Storage Elements (SE) in a multiprocessing configuration. I/O control units attach to the IOCE via the channels. The IOCE can also operate as a processor under control of the 7201-02 Computing Element. The IOCE can perform I/O operations and processing concurrently. The IOCE has the capability of working simultaneously with one device on each selector channel and all devices on the multiplexor channel.

The 7231-02 incorporates extensive error checking, diagnostic and service aids.

IBM 7289-02 Peripheral Adapter Modules

The IBM 7289-02 Peripheral Adapter Module (PAM) provides for the on-line attachment of remote and local peripheral devices to the

9020D System. PAM controls the communication of data between the IOCE and such typical peripheral devices as Teletypewriters, Lenkurt 26B, and the 1052 Printer Keyboard.

PAM is functionally divided into PAM Common and PAM Adapters. PAM Common provides addressing, priority, configuration and general controls to service all adapters. The adapters provide all necessary bit/byte conversion, data control, message initiation, message termination, and matching of device electrical interface characteristics.

The PAM satisfies two basic requirements for real-time processing:

1. Subchannels to provide entry points for multiple devices and a wide range of data rates and message lengths.
2. Priority control of data transfers and program interruptions as appropriate for individual system configuration.

IBM 2803-01 Tape Control Units

The Tape Control Unit (TCU) provides the control functions and control lines for the magnetic tape units. Each TCU allows for the connection of up to eight tape units, and it is connected in parallel to two selector channels in different IOCEs.

IBM 2314-A1 Storage Control Units

The Storage Control Unit (SCU) provides the control functions and control lines for the disk storage units. Each SCU allows for the connection of five disk storage units (nine disk drives), and it is connected in parallel to two selector channels in different IOCEs.

IBM 7265-02 System Console

The IBM 7265-02 System Console is the central monitoring and control position in the IBM 9020D System. The console is divided functionally into four parts: Maintenance Controls, Monitor Displays, Operator's Controls, and Emergency Power Off.

The console is addressable as an I/O device to display the system mode of operation, generate audible alarms, and display updated system element configurations. The System Console contains logic to electronically switch a Printer Keyboard and a Card Read/Punch and Printer to the selected Multiplexor Channel. Switching is under manual control of switches located on the Operators Panel. Operator controls which could disrupt the system program or elements are interlocked on the control panel.

The System Console contains the following indicators and controls for monitoring and operating the IBM 9020D System:

1. Unit error and status indicators.
2. Manual controls and switches for the peripheral equipment.
3. Data and sense switches.
4. Computing element register display.
5. Power indicators.
6. Initial program loading and other unit-control switches.

All critical console functions are duplicated elsewhere in the system.

Input/Output Equipment

The I/O equipment provided with the IBM 9020D System consists of tape units, two printers, a card reader/punch, integrated control units for controlling the printers and card read punch, and three printer keyboards.

FORMATS AND CODES

Instruction and Data Formats

9020D System information relationships, data, and operation code formats are shown in Figure 2.

Code Conversion Charts

The charts and procedures for binary, hexadecimal, decimal, fraction, and number conversion are shown in Figure 3. The two standard data codes are the Extended Binary-Coded-Decimal Interchange Code (EBCDIC) and the United States of America Standard Code for Information Interchange (USASCII-8). The numbering conventions for the bit positions within a character differ for each code. The conventions are:

<u>Code</u>	<u>Bit Positions</u>
EBCDIC	0 1 2 3 4 5 6 7
USASCII-8	8 7 6 5 4 3 2 1

The EBCDIC codes are shown in Figure 4; the USASCII-8 codes, in Figure 5.

Programming Considerations, General

Information Handling

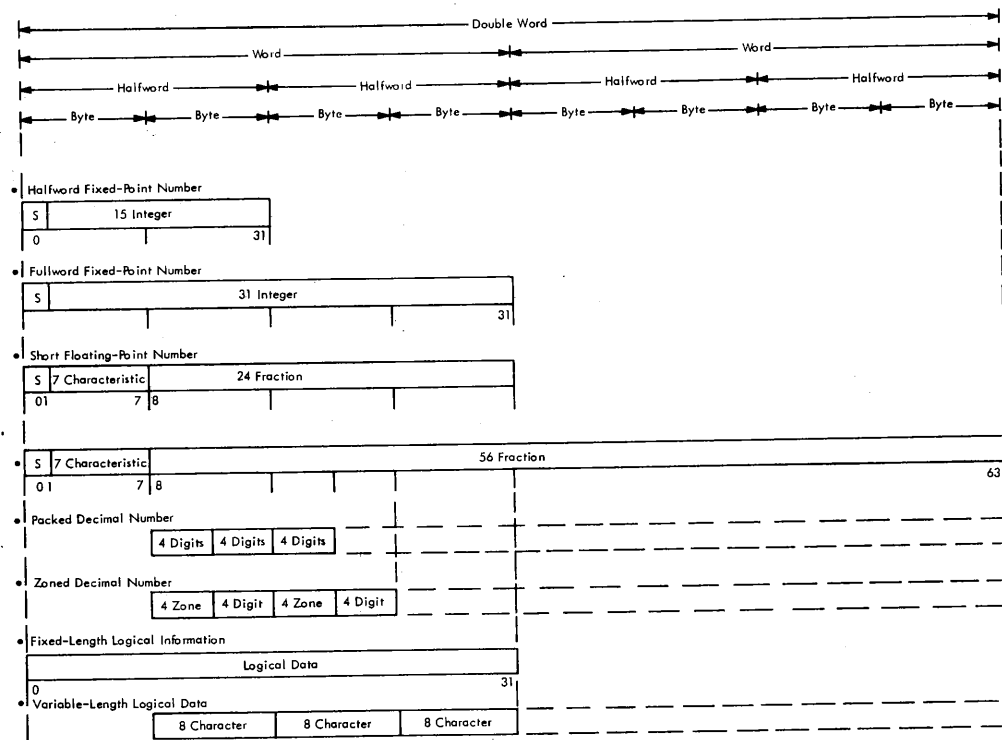
The IBM 9020D can perform three types of arithmetic operations: fixed-point, floating-point, and decimal. The CE can handle any type of eight-bit character set; however, certain restrictions are assumed in the decimal arithmetic and editing operations. All character-set sensitive I/O equipment assumes either Extended Binary-Coded-Decimal Interchange Code (EBCDIC) or the United States of America Standard Code for Information Interchange (USASCII). See Figures 4 and 5 respectively. The numbering convention within a character differs between the EBCDIC and USASCII codes. (Refer to Code Conversion Charts discussion.)

These codes do not have a graphic defined for all eight-bit codes. If representation of all possible bit patterns is desired, a hexadecimal representation may be used (Figure 6). The hexadecimal representation uses one graphic for a four-bit code; therefore, two graphics are used for an eight-bit code.

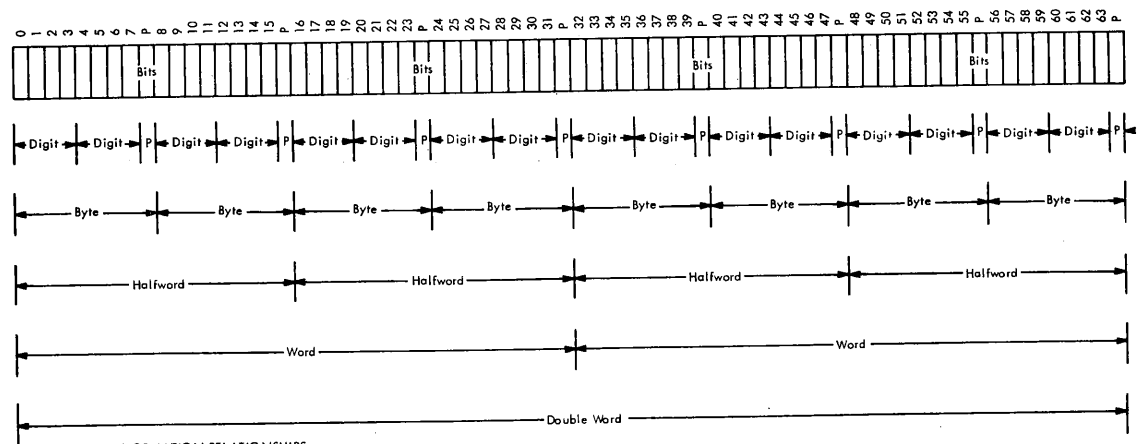
Instruction Format

The length of an instruction format can be one, two, or three half-words. It is related to the number of storage addresses necessary

for the operation. An instruction consisting of only one halfword causes no reference to main storage. A two-halfword instruction provides one storage-address specification, and a three-halfword instruction provides two storage-address specifications. All instructions must be located in storage on integral boundaries for halfwords.



DATA FORMATS



NOTE: The parity bits are on the left-hand side of the bytes when indicated on the console and on the right-hand side of the bytes in storage.

Figure 2. Instruction and Data Formats (Sheet 1 of 2)

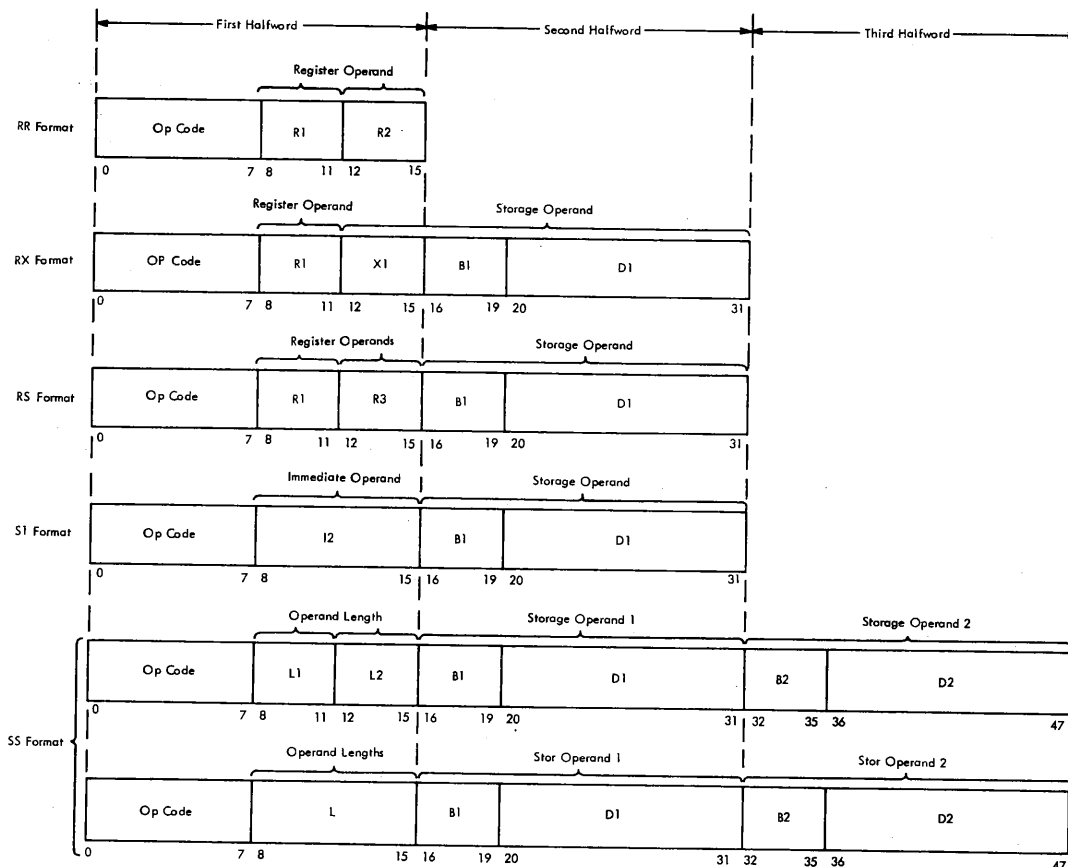


Figure 2. Instruction and Data Formats (Sheet 2 of 2)

The five basic instruction formats (Figure 2) are denoted by the format codes RR, RX, RS, SI and SS. The format codes express in general terms the operation to be performed. RR denotes a register-to-register operation; RX a register-to-indexed-storage operation; RS a register-to-storage operation; SI a storage and immediate-operation operation; and SS a storage-to-storage operation. A detailed listing of all IBM 9020D System instructions appears in the appendix of this publication.

Main Storage Addressing

Byte locations in storage are consecutively numbered starting with 0, each number considered to be the address of the corresponding byte. A group of bytes in storage is addressed by the leftmost byte of the group. The addressing capability permits a maximum of 16,777,216 bytes, using a 24-bit binary address. This set of main-storage addresses includes some locations reserved for special purposes.

Digital Conversion

Binary to Hex to Decimal (Integers only)

Binary	Hex	Decimal				
		16 ⁴	16 ³	16 ²	16 ¹	16 ⁰
0001	1	65,536	4,096	256	16	1
0010	2	131,072	8,192	512	32	2
0011	3	196,608	12,288	768	48	3
0100	4	262,144	16,384	1,024	64	4
0101	5	327,680	20,480	1,280	80	5
0110	6	393,216	24,576	1,536	96	6
0111	7	458,752	28,672	1,792	112	7
1000	8	524,288	32,768	2,048	128	8
1001	9	589,824	36,864	2,204	144	9
1010	A	655,360	40,960	2,560	160	10
1011	B	720,896	45,056	2,816	176	11
1100	C	786,432	49,152	3,072	192	12
1101	D	851,968	53,248	3,328	208	13
1110	E	917,504	57,344	3,584	224	14
1111	F	983,040	61,440	3,840	240	15

Procedure:

1. Separate binary number (by spacing) into groups of 4 bits each, from the right. Add leading zeros, if necessary, for leftmost group. Thus:
Binary 110110110 = 0001 1011 0110
2. Using first two columns of table, convert each group of 4 binary bits into hexadecimal, thus:
Binary 0001 1011 0110 = hex 1B6
3. Working from right, relate bits of hex number to associated decimal column, thus 6 relates to 16⁰ column, B to 16¹ column, and 1 to 16² column. Using bits in hex column as reference, find associated decimal part; add decimal parts for decimal total:
Hex 6 = (16⁰ column) Decimal 6
Hex B = (16¹ column) Decimal 176
Hex 1 = (16² column) Decimal 256
Total: Decimal 438

NOTE: As the digital conversion problem grows more complex, expanded tables may be necessary. Accordingly, the Hexadecimal and Decimal Integer Conversion Table below is an expansion of the first, simple conversion table. The expanded table has three more higher-order hex columns. Use the same method to convert integers; the only difference is the wider range of this second table.

Hexadecimal and Decimal Integer Conversion Table

HALF WORD								HALF WORD							
BYTE				BYTE				BYTE				BYTE			
0123		4567		0123		4567		0123		4567		0123		4567	
Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	268,435,456	1	16,777,216	1	1,048,576	1	65,536	1	4,096	1	256	1	16	1	1
2	536,870,912	2	33,554,432	2	2,097,152	2	131,072	2	8,192	2	512	2	32	2	2
3	805,306,368	3	50,331,648	3	3,145,728	3	196,608	3	12,288	3	768	3	48	3	3
4	1,073,741,824	4	67,108,864	4	4,194,304	4	262,144	4	16,384	4	1,024	4	64	4	4
5	1,342,177,280	5	83,886,080	5	5,242,880	5	327,680	5	20,480	5	1,280	5	80	5	5
6	1,610,612,736	6	100,663,296	6	6,291,456	6	393,216	6	24,576	6	1,536	6	96	6	6
7	1,879,048,192	7	117,440,512	7	7,340,032	7	458,752	7	28,672	7	1,792	7	112	7	7
8	2,147,483,648	8	134,217,728	8	8,388,608	8	524,288	8	32,768	8	2,048	8	128	8	8
9	2,415,919,104	9	150,994,944	9	9,437,184	9	589,824	9	36,864	9	2,304	9	144	9	9
A	2,684,354,560	A	167,772,160	A	10,485,760	A	655,360	A	40,960	A	2,560	A	160	A	10
B	2,952,790,016	B	184,549,376	B	11,534,336	B	720,896	B	45,056	B	2,816	B	176	B	11
C	3,221,225,472	C	201,326,592	C	12,582,912	C	786,432	C	49,152	C	3,072	C	192	C	12
D	3,489,660,928	D	218,103,808	D	13,631,488	D	851,968	D	53,248	D	3,328	D	208	D	13
E	3,758,096,384	E	234,881,024	E	14,680,064	E	917,504	E	57,344	E	3,584	E	224	E	14
F	4,026,531,840	F	251,658,240	F	15,728,640	F	983,040	F	61,440	F	3,840	F	240	F	15
	8		7		6		5		4		3		2		1

Figure 3. Binary, Hexadecimal, Decimal, Fraction, and Number Conversion Charts (Sheet 1 of 4)

Hexadecimal and Decimal Fraction Conversion Table

HALF WORD											
BYTE				BYTE				BYTE			
0123		4567		0123		4567		0123		4567	
Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal
.0	.0000	.00	.0000 0000	.000	.0000 0000 0000	.0000	.0000 0000 0000	.0000	.0000 0000 0000	.0000	.0000 0000 0000
.1	.0625	.01	.0039 0625	.001	.0002 4414 0625	.0001	.0000 1525 8789 0625	.0001	.0000 1525 8789 0625	.0001	.0000 1525 8789 0625
.2	.1250	.02	.0078 1250	.002	.0004 8828 1250	.0002	.0000 3051 7578 1250	.0002	.0000 3051 7578 1250	.0002	.0000 3051 7578 1250
.3	.1875	.03	.0117 1875	.003	.0007 3242 1875	.0003	.0000 4577 6367 1875	.0003	.0000 4577 6367 1875	.0003	.0000 4577 6367 1875
.4	.2500	.04	.0156 2500	.004	.0009 7656 2500	.0004	.0000 6103 5156 2500	.0004	.0000 6103 5156 2500	.0004	.0000 6103 5156 2500
.5	.3125	.05	.0195 3125	.005	.0012 2070 3125	.0005	.0000 7629 3945 3125	.0005	.0000 7629 3945 3125	.0005	.0000 7629 3945 3125
.6	.3750	.06	.0234 3750	.006	.0014 6484 3750	.0006	.0000 9155 2734 3750	.0006	.0000 9155 2734 3750	.0006	.0000 9155 2734 3750
.7	.4375	.07	.0273 4375	.007	.0017 0898 4375	.0007	.0001 0681 1523 4375	.0007	.0001 0681 1523 4375	.0007	.0001 0681 1523 4375
.8	.5000	.08	.0312 5000	.008	.0019 5312 5000	.0008	.0001 2207 0312 5000	.0008	.0001 2207 0312 5000	.0008	.0001 2207 0312 5000
.9	.5625	.09	.0351 5625	.009	.0021 9726 5625	.0009	.0001 3732 9101 5625	.0009	.0001 3732 9101 5625	.0009	.0001 3732 9101 5625
.A	.6250	.0A	.0390 6250	.00A	.0024 4140 6250	.000A	.0001 5258 7890 6250	.000A	.0001 5258 7890 6250	.000A	.0001 5258 7890 6250
.B	.6875	.0B	.0429 6875	.00B	.0026 8554 6875	.000B	.0001 6784 6679 6875	.000B	.0001 6784 6679 6875	.000B	.0001 6784 6679 6875
.C	.7500	.0C	.0468 7500	.00C	.0029 2968 7500	.000C	.0001 8310 5468 7500	.000C	.0001 8310 5468 7500	.000C	.0001 8310 5468 7500
.D	.8125	.0D	.0507 8125	.00D	.0031 7382 8125	.000D	.0001 9836 4257 8125	.000D	.0001 9836 4257 8125	.000D	.0001 9836 4257 8125
.E	.8750	.0E	.0546 8750	.00E	.0034 1796 8750	.000E	.0002 1362 3046 8750	.000E	.0002 1362 3046 8750	.000E	.0002 1362 3046 8750
.F	.9375	.0F	.0585 9375	.00F	.0036 6210 9375	.000F	.0002 2888 1835 9375	.000F	.0002 2888 1835 9375	.000F	.0002 2888 1835 9375
1		2		3		4					

Example of use of fraction table. Convert hex .ABC to decimal value:

Find: .A (highest order) = .6250
 .0B (next order) = .0429 6875
 .00C (next order) = .0029 2968 7500

Add all ordered values: = .6708 9843 7500 (decimal equivalent)

NOTE: If the problem were to convert hex 1B6.ABC to decimal value, all that would be necessary has been shown above and in the first example (consider the two examples combined). The decimal equivalent is: 438.6708 9843 7500.

Example of use of combined tables for floating-point problem.

Given: Decimal value 149.25.

Find: Equivalent hex value, then convert result to floating-point value.

From Tables: Decimal 149 = 95 hex
 0.25 = 0.4 hex

Add all ordered values: 1.49 = 95.4 hex

Partial result, expressed in subscript base notation:

$149.25_{10} = 95.4_{16}$. This resolves to: 0.954×16^2 .

Characteristic: Excess 64 + 2 = 1000010 (binary)

Fraction: $0.954_{16} = .1001\ 0101\ 0100$ (binary)

Add positive sign bit with following zeros to complete short floating-point number:

S Char	Fraction
01000010	1001 0101 0100 0000 0000

A fraction is normalized when the high-order digit (bit positions 8-11) is not equal to zero. It is un-normalized if the high-order digit contains all zeros. To normalize: Left-shift fraction (4 bits) until the nonzero digit occupies the high-order digit position. Reduce the characteristic by 1 for each digit shifted.

For detailed description of floating-point arithmetic, see IBM System/360 Principles of Operation, Form A22-6821.

Figure 3. Binary, Hexadecimal, Decimal, Fraction, and Number Conversion Charts (Sheet 2 of 4)

TO CONVERT HEXADECIMAL TO DECIMAL

1. Locate the column of decimal numbers corresponding to the left-most digit or letter of the hexadecimal; select from this column and record the number that corresponds to the position of the hexadecimal digit or letter.
2. Repeat step 1 for the next (second from the left) position.
3. Repeat step 1 for the units (third from the left) position.
4. Add the numbers selected from the table to form the decimal number.

EXAMPLE	
Conversion of Hexadecimal Value	D34
1. D	3328
2. 3	48
3. 4	4
4. Decimal	3380

To convert integer numbers greater than the capacity of table, use the techniques below:

HEXADECIMAL TO DECIMAL

Successive cumulative multiplication from left to right, adding units position.

Example: $D34_{16} = 3380_{10}$

$$\begin{array}{r}
 D = 13 \\
 \times 16 \\
 \hline
 208 \\
 + 3 \\
 \hline
 211 \\
 \times 16 \\
 \hline
 3376 \\
 + 4 \\
 \hline
 3380
 \end{array}$$

TO CONVERT DECIMAL TO HEXADECIMAL

1. (a) Select from the table the highest decimal number that is equal to or less than the number to be converted.
(b) Record the hexadecimal of the column containing the selected number.
(c) Subtract the selected decimal from the number to be converted.
2. Using the remainder from step 1 (c) repeat all of step 1 to develop the second position of the hexadecimal (and a remainder).
3. Using the remainder from step 2 repeat all of step 1 to develop the units position of the hexadecimal.
4. Combine terms to form the hexadecimal number.

EXAMPLE	
Conversion of Decimal Value	3380
1. D	-3328
	52
2. 3	-48
	4
3. 4	-4
4. Hexadecimal	D34

DECIMAL TO HEXADECIMAL

Divide and collect the remainder in reverse order.

Example: $3380_{10} = X_{16}$

$$\begin{array}{rcl}
 16 \overline{) 3380} & \rightarrow & \text{remainder} \\
 16 \overline{) 211} & \rightarrow & 3 \\
 16 \overline{) 13} & \rightarrow & D
 \end{array}
 \quad 3380_{10} = D34_{16}$$

Figure 3. Binary, Hexadecimal, Decimal, Fraction, and Number Conversion Charts (Sheet 3 of 4)

An addressing exception is recognized when any part of an operation is located beyond the available storage capacity of an installation, or located outside the configured storage, or the storage assigned by the storage address translator for a particular CE or IOCE. The addressing exception is only recognized when the address is actually used to attempt an access, and not during an address manipulation operation prior to its use.

In the IBM 9020D/E Systems main storage may be shared by more than one CE and/or IOCE. The address of a byte location is determined by the content of a ten-position storage address translator (ATR) in each accessing element. Addresses generated automatically by the CE are relocated using the current value of the preferential-storage base address. When the preferential-storage base address is other than zero, accesses to the first 4096-byte block of main storage are relocated, and therefore are not available to the programmer.

PROGRAMMING NOTE

The IBM 9020D System uses Storage Elements (SE) in modules of 131,072 words (or 524,288 bytes) each. The 9020D configuration provides 3,145,728 bytes of storage, expandable to 5,242,880 bytes, which represents six and ten modules, respectively. Byte addresses extend from 0 to 3,145,727 or 5,242,879 inclusive for main storage in a 9020D system.

2^n	n	2^{-n}	16^n	n
1	0	1.0	1	0
2	1	0.5	16	1
4	2	0.25	256	2
8	3	0.125	4 096	3
			65 536	4
16	4	0.062 5	1 048 576	5
32	5	0.031 25	16 777 216	6
64	6	0.015 625	268 435 456	7
128	7	0.007 812 5	4 294 967 296	8
			68 719 476 736	9
256	8	0.003 906 25	1 099 511 627 776	10 = A
512	9	0.001 953 125	17 592 186 044 416	11 = B
1 024	10	0.000 976 562 5	281 474 976 710 656	12 = C
2 048	11	0.000 488 281 25	4 503 599 627 370 496	13 = D
			72 057 594 037 927 936	14 = E
4 096	12	0.000 244 140 625	1 152 921 504 606 846 976	15 = F
8 192	13	0.000 122 070 312 5		
16 384	14	0.000 061 035 156 25		
32 768	15	0.000 030 517 578 125		
65 536	16	0.000 015 258 789 062 5		
131 072	17	0.000 007 629 394 531 25		
262 144	18	0.000 003 814 697 265 625		
524 288	19	0.000 001 907 348 632 812 5		
1 048 576	20	0.000 000 953 674 316 406 25		
2 097 152	21	0.000 000 476 837 158 203 125		
4 194 304	22	0.000 000 238 418 579 101 562 5		
8 388 608	23	0.000 000 119 209 289 550 781 25		
16 777 216	24	0.000 000 059 604 644 775 390 625		
33 554 432	25	0.000 000 029 802 322 387 695 312 5		
67 108 864	26	0.000 000 014 901 161 193 847 656 25		
134 217 728	27	0.000 000 007 450 580 596 923 828 125		
268 435 456	28	0.000 000 003 725 290 298 461 914 062 5		
536 870 912	29	0.000 000 001 862 645 149 230 957 031 25		
1 073 741 824	30	0.000 000 000 931 322 574 615 478 515 625		
2 147 483 648	31	0.000 000 000 465 661 287 307 739 257 812 5		
4 294 967 296	32	0.000 000 000 232 830 643 653 869 628 906 25		
8 589 934 592	33	0.000 000 000 116 415 321 826 934 814 453 125		
17 179 869 184	34	0.000 000 000 058 207 660 913 467 407 226 562 5		
34 359 738 368	35	0.000 000 000 029 103 830 456 733 703 613 281 25		

Decimal Values

Figure 3. Binary, Hexadecimal, Decimal, Fraction, and Number Conversion Charts (Sheet 4 of 4)

In the IBM 9020D System, main storage may be shared by more than one CE. The address of a byte location is normally the same for each CE.

Fixed-length fields, such as halfwords and doublewords, must be located in main storage on an integral boundary for that unit of information. A boundary is called integral for a unit of information when its storage address is a multiple of the length of the unit in bytes. For example, words (four bytes) must be located in storage so that their address is a multiple of the number 4 (4, 8, 12, 16, etc). A halfword (two bytes) must have an address which is a multiple of the number 2 (2, 4, 6, 8, etc). A doubleword (eight bytes) must have an address which is a multiple of the number 8 (8, 16, 24, 32, etc).

Bit Positions 4,3,2,1 Second Hexadecimal Digit		00				01				10				11				Bit Positions 8,7 Bit Positions 6,5 First Hexadecimal Digit	
		00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11		
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F		
0000	0	NUL	DLE			SP	0					(C)	P			~	p		
0001	1	SOH	DC1			!①	1					A	Q			a	q		
0010	2	STX	DC2			"	2					B	R			b	r		
0011	3	ETX	DC3			#	3					C	S			c	s		
0100	4	EOT	DC4			\$	4					D	T			d	t		
0101	5	ENQ	NAK			%	5					E	U			e	u		
0110	6	ACK	SYN			&	6					F	V			f	v		
0111	7	BEL	ETB			'	7					G	W			g	w		
1000	8	BS	CAN			(	8					H	X			h	x		
1001	9	HT	EM			)	9					I	Y			i	y		
1010	A	LF	SUB			*	:					J	Z			j	z		
1011	B	VT	ESC			+	;					K	[			k	{		
1100	C	FF	FS			,	<					L	\			l			
1101	D	CR	GS			-	=					M	]			m	}		
1110	E	SO	RS			.	>					N	^②			n	~		
1111	F	SI	US			/	?					O	—			o	DEL		

① If IBM equipment implementing USASCII-8 is provided, the graphic | (Logical OR) will be used instead of ! (Exclamation Point).

② If IBM equipment implementing USASCII-8 is provided, the graphic ¬ (Logical NOT) will be used instead of ^ (Circumflex).

NOTE: Current activities in committees under the auspices of the United States of America Standards Institute may result in changes to the characters and/or structure of the eight-bit representation of USASCII devised by the Institute. Such changes may cause the eight-bit representation of USASCII implemented in System/360 (USASCII-8) to be different from a future USA Standard. Since a difference of this nature may eventually lead to a modification of System/360, it is recommended that users avoid: (1) operation with PSW bit 12 set to 1, and (2) the use of any sign codes in decimal data other than those preferred for EBCDIC.

Control Character Representations

NUL	Null	DLE	Data Link Escape (CC)
SOH	Start of Heading (CC)	DC1	Device Control 1
STX	Start of Text (CC)	DC2	Device Control 2
ETX	End of Text (CC)	DC3	Device Control 3
EOT	End of Transmission (CC)	DC4	Device Control 4
ENQ	Enquiry (CC)	NAK	Negative Acknowledge (CC)
ACK	Acknowledge (CC)	SYN	Synchronous Idle (CC)
BEL	Bell	ETB	End of Transmission Block (CC)
BS	Backspace (FE)	CAN	Cancel
HT	Horizontal Tabulation (FE)	EM	End of Medium
LF	Line Feed (FE)	SUB	Substitute
VT	Vertical Tabulation (FE)	ESC	Escape
FF	Form Feed (FE)	FS	File Separator (IS)
CR	Carriage Return (FE)	GS	Group Separator (IS)
SO	Shift Out	RS	Record Separator (IS)
SI	Shift In	US	Unit Separator (IS)
		DEL	Delete
(CC)	Communication Control		
(FE)	Format Effector		
(IS)	Information Separator		

Special Graphic Characters

SP	Space	<	Less Than
!	Exclamation Point	=	Equals
	Logical OR	>	Greater Than
"	Quotation Marks	?	Question Mark
#	Number Sign	@	Commercial At
\$	Dollar Sign	[	Opening Bracket
%	Percent	\	Reverse Slant
&	Amperсанд	]	Closing Bracket
'	Apostrophe	^	Circumflex
(	Opening Parenthesis	¬	Logical NOT
)	Closing Parenthesis	~	Underline
*	Asterisk	˘	Grave Accent
+	Plus	{	Opening Brace
,	Comma		Vertical Line (This graphic is stylized to distinguish it from Logical OR)
-	Hyphen (Minus)	}	Closing Brace
.	Period (Decimal Point)	~	Tilde
/	Slant		
:	Colon		
;	Semicolon		

Figure 5. United States of America Standard Code for Information Interchange

Hexadecimal Code	Printed Graphic	EBCDIC Code	USASCII-8 Code
0000	0	1111 0000	0101 0000
0001	1	1111 0001	0101 0001
0010	2	1111 0010	0101 0010
0011	3	1111 0011	0101 0011
0100	4	1111 0100	0101 0100
0101	5	1111 0101	0101 0101
0110	6	1111 0110	0101 0110
0111	7	1111 0111	0101 0111
1000	8	1111 1000	0101 1000
1001	9	1111 1001	0101 1001
1010	A	1100 0001	1010 0001
1011	B	1100 0010	1010 0010
1100	C	1100 0011	1010 0011
1101	D	1100 0100	1010 0100
1110	E	1100 0101	1010 0101
1111	F	1100 0110	1010 0110

Figure 6. Hexadecimal Representation

Storage addresses are expressed in binary form. In binary, integral boundaries for halfwords, words, and doublewords can be specified only by the binary addresses in which one, two, or three of the low-order bits are zero, respectively (Figure 3). For example the integral boundary for a word is a binary address in which the two low-order positions are zero.

Variable fields are not limited to integral boundaries, but may start on any byte location.

OPERATOR CONTROLLED EQUIPMENT

The IBM 9020D System has been designed so that a minimum of operator action is required for system operation. There are six pieces of equipment that the operator can actively control: System Console, IBM 2540 Card Read Punch, IBM 1403 Printer, IBM 1052 Printer/Keyboard, IBM 2312/2318 Disk Storage Unit and IBM 2401 Magnetic Tape Unit. The following sections of this manual contain information needed to operate this equipment. More detailed information can be found in the IBM 9020D and 9020E System Principles of Operation manual, Form A27-2434.

SYSTEM CONSOLE

The IBM 7265-02 System Console (Figure 7) provides central monitoring and controlling capabilities for the IBM 9020D System. Functionally, the console is separated into four major sections: monitor displays, operator control, maintenance control and data entry.

Functional Organization

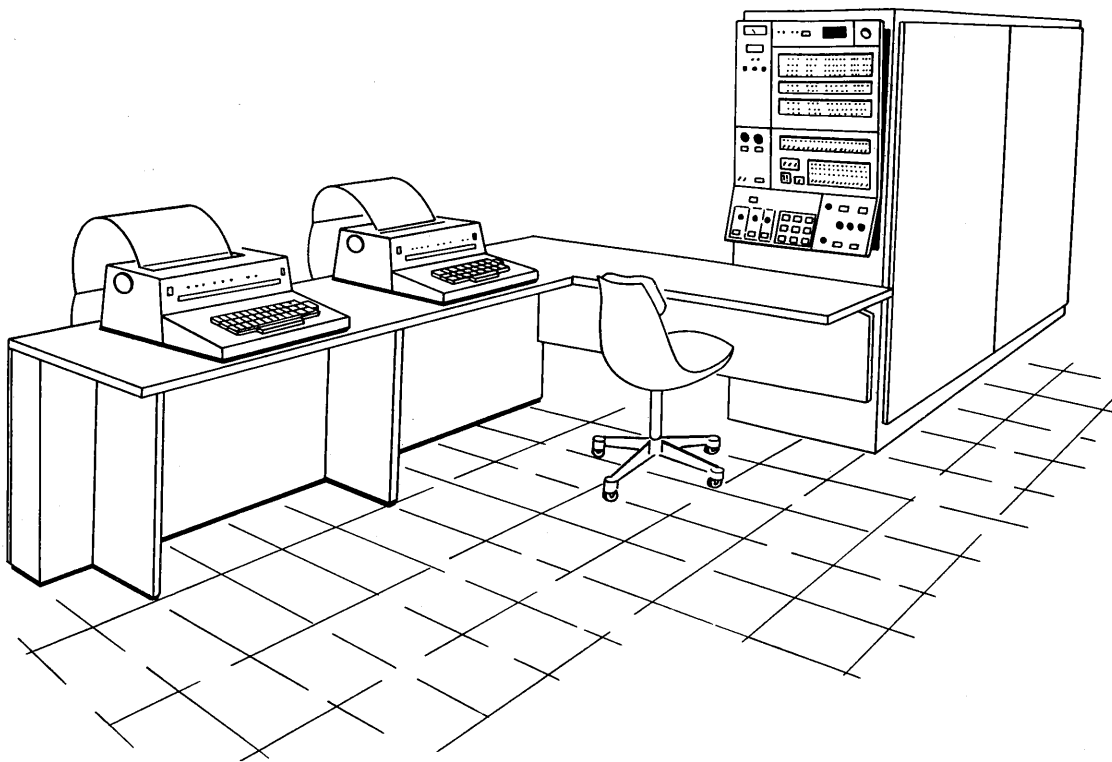


Figure 7. System Console

Monitor Displays

The console is interconnected with various system elements and is also program addressable as an input/output (I/O) device to display information about the system operation. Some of these displays are: mode of operation, system element configuration, power supply status, various program error indications, and machine malfunction indications.

Operator Control

An operator control panel (Figure 8) is located in the center front section of the console. This panel contains various switches and lights to permit the operator to control and monitor the system operation. The console operator can control such operations as initial program loading (IPL), console power on/off sequencing, system element configuration selection, etc. Operator controls that interrupt the active program are interlocked on the control panel.

Figure 8. 9020D System Console Operator's Panel

Data Entry

An L-shaped reading board, on which one or more IBM 1052 Printer/Keyboards are mounted, is attached to the system console (Figure 7). The 1052 units permit data communication between the operator and the system. One 1052 enters data through a subchannel in the console circuitry, and another 1052 enters data through a subchannel in the Peripheral Adapter Module (PAM). For maximum flexibility, the console-connected 1052 can be manually switched (from the operator control panel) to any of the three input/output control element (IOCE) interfaces. In addition, through use of a patch panel at the system console, the 1052's may be electrically interchanged.

Controls and Indicators

The controls and indicators on the operator's control panel are located on eight panels designated A through H. (See Figure 8). The operational environment for the various system console switches is given in Table 1.

NOTE: Certain controls on the operator's control panel are interlocked by the key-operated system interlock switch (lower, right corner on Figure 8). This switch must be on before the interlocked controls are operative. The interlocked controls are indicated by an asterisk (*) on Table 1.

Panel A

The controls and indicators on panel A permit selection monitoring of the console power supplies.

Power Supply Select Switch - This switch is used for selecting one of the two (A or B) console power supply sets.

+6MA (Marginal A) and +6MB (Marginal B) Adjustment Controls - These slotted controls are used to vary the selected +6 volt DC power supply (as selected by the power supply select switch) from +5 to +7 volts DC. The indicator above each control is on any time the selected power supply is not at its nominal value. Normally, these controls are for customer engineering use only.

NOTE: Neither of the two indicators above the +6MA and +6MB controls should be on during normal system operation.

Local Storage Map - The Local Store map for the 9020D System Console is shown in Figure 8. The map indicates Address switch settings required to display General Registers, Floating-Point Registers, or the Working Register.

When bit 27 is set to zero, bits 28-31 are used to select one of the sixteen General Registers in Local Storage. The registers (0-15) are addressed by binary settings of 0000 through 1111 respectively.

Table 1. State Dependent Operator Switches

	CE PROGRAM STATE		SYSTEM CONSOLE OR CONFIGURATION CONSOLE CONTROLS						CE PANEL CONTROLS					
			SYSTEM INTERLOCK SWITCH						SYSTEM INTERLOCK SWITCH					
			OFF ON						OFF ON					
	O P E R	S T O P	CE STATE						CE STATE					
			3	2	1	0	T		3	2	1	0	T	
ACTIVATE		X							X	X	X	X		
ADDRESS COMPARE	X								X	X	X	X		
ADDRESS SWITCHES*									X	X	X	X		
ALL STOP	X								X	X	X	X		
CE SELECT*									X	X	X	X		
CONTROL CE*									X	X	X	X		
DATA SWITCHES*									X	X	X	X		
DISPLAY		X							X	X	X	X		
ELEMENT MPO	X	X							X	X	X	X		
EMERGENCY PULL	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ENABLE (FOR ADDR COMP)	X								X	X	X	X		
ENABLE (FOR I/O SELECT)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
INTERRUPT	X	X							X	X	X	X		
I/O SELECT SWITCHES	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LOAD	X	X							X	X	X	X		
LOAD UNIT*									X	X	X	X		
MAIN STORAGE SELECT*									X	X	X	X		
POWER OFF+	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PSW RESTART	X	X							X	X	X	X		
RATE	X	X							X	X	X	X		
SENSE SWITCHES	X		X	X	X	X	X	X	X	X	X	X	X	X
SET IC		X							X	X	X	X		
START		X							X	X	X	X		
STORAGE SELECT SWITCH*									X	X	X	X		
STORE		X							X	X	X	X		
STOP	X								X	X	X	X		
SYSTEM INTERLOCK SWITCH	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TEST SWITCH	X	X							X	X			X	X
S/360 MODE SWITCH	X	X							X	X	X		X	X

NOTES: X - Yes, Control is Functional

T - State Zero, Test Switch on

* - Static, Requires use of Other Control

+ - Not Interlocked on System Console, but System Console Control only turns off System Console Power. Not Interlocked on Configuration Console, but Configuration Console Control only turns off Power to the System Console Portion of

the Configuration Console. The Reconfiguration Control Units housed within the Configuration Console have separate, State-Dependent Power Control Switches.-

Setting the Address switches bits 27 to 1 and bit 28 to 0 selects the Floating-Point Registers. The eight (16-24) FP registers are addressed by bits 29-31 with binary setting 000 through 111 respectively. When bits 27 and 28 of the Address switches are both set to one, the Working Register is selected. The contents of the remainder of the Address switches are not used.

Console Voltmeter - This meter is used for monitoring the output of the selected +6 volt DC power supply. The meter is intended for customer engineering use only.

Calibrate Jacks - The jacks are used for calibrating the console voltmeter. They are intended for customer engineering use only.

Panel B

The controls and indicators on panel B permit monitoring of system and console power conditions. In addition, the system performance can be monitored.

System Power Indicators - Summarize system power status.

Standby - Indicates when the prime AC input power to the system is being supplied by the standby source.

Battery - Indicates when one or more of the system elements has switched to battery power. The indicator turns off when the element on battery power switches back to main or standby power. The indicators function regardless of console power status.

Console Power Indicators - Summarize System Console power status.

Mainline On - Indicates when the main console breaker is on. The indicator functions when prime AC is being supplied to the console. Furthermore, this indicator is independent of the Power On-Off switch operation.

Power Check - Indicates that one or more of the following conditions exist in the console power system:

1. A catastrophic power failure has occurred.
2. A temperature in excess of 130°F exists in the console.
3. A normal power-off operation has taken place (Power On-Off switch to the Off position).

NOTE: If the power check indicator is on because of conditions 1 or 2, notify the customer engineer.

Thermal Check - Indicates that the console operating temperature has exceeded 120°F. The indicator can be turned off only by depressing the Thermal Reset switch.

Thermal Reset Switch - Depressing this switch turns off the Thermal Check indicator when the console operating temperature is below 120°F. NOTE: If the Thermal Check indicator is not turned off after having depressed the Thermal Reset switch, the customer engineer should be notified.

Mode of Operation Indicator - This indicator (located to the right of the Thermal Reset switch) indicates the system operating capabilities. The display is a two-character alphameric code. The alphabetical character appears on the left of the display and the numerical character appears on the right. The displayed alphabetical characters are A, B, and C. The numerical characters are 1-7. When the system interlock is on, a red light is turned on in the mode of operation indicator.

Panel C

This panel contains the Emergency Pull switch.

Emergency Pull Switch - Pulling out on this switch causes all IBM 9020D System power to be removed within two seconds. However, power is still present within the prime power compartments of each system element.

NOTE: The Emergency Pull switch is mechanical latch type switch that must be manually reset after it is operated. A customer engineer must perform the reset task. After the switch is reset, power automatically sequences up on all units having their power switch in the On position.

Panel D

The indicators on panel D permit monitoring of the status, alarm condition, and system configuration of the five main elements.

Status Indicators - Four indicators are used to indicate the unit status (state 0-3) for each of the following:

1. Computing Element
2. Input/Output Control Element
3. Main Storage
4. Peripheral Adapter Module
5. Tape Control Unit
6. Storage Control Unit

Only one of the four state indicators is on for an element at a given time. No status indicator will be on for any element having power down.

Alarm Indicators - Two indicators are used to indicate a power or logic malfunction in each of the elements mentioned in the preceding paragraph. The alarm indicators are designated as:

Power Check - These indicators indicate that one or more of the following conditions exist in the element causing the alarm:

1. A catastrophic power failure exists.
2. An over-temperature condition exists.
3. A normal power-off condition exists.

Logic Check - These indicators indicate that a system element has detected its own logic check condition. If even parity is transferred from the console to a computing element, that computing element turns on its corresponding Logic Check indicator.

Configuration Indicators - Four registers of indicators (1, 2, and 3) are used to indicate the system configuration. These registers are program controlled and remain on until they are updated by the program or reset by the Console Reset switch.

Panel E

The controls on panel E permit I/O selection and limited computing element configuration control.

I/O Select Switches - Allows selection of the Reader/Punch Printer or Printer/Keyboard.

Reader/Punch-Printer - This switch enables the selection of one of the three IOCE interfaces (1, 2, or 3) for interconnection to the IBM 2540 Card Read Punch and the IBM 1403 Printer.

Enable Switch (Reader/Punch-Printer) - This switch conditions the selection made by the Reader/Punch-Printer select switch. A light within the switch is turned on at the completion of the switching operation, and remains on until the select switch setting is changed. Returning the select switch to the original position causes the switch indicator to turn on.

Printer Keyboard - This switch enables the selection of one of the three IOCE interfaces (1, 2, or 3) for interconnection to the console-connected IBM 1052 Printer/Keyboard.

Enable Key (Printer Keyboard) - This switch is associated with the Printer Keyboard Select switch and works in a manner similar to the Reader/Punch-Printer Enable switch.

Control CE Switches - One switch is provided for each computing element to allow manual updating of the SCON bits in the configuration register. This enables a minimum amount of operator control of the computing element configuration. These switches are not conditioned until the Control CE-Activate switch is depressed.

Control CE-Activate Switch - Depressing this switch transfers the setting of the Control CE switches to the SCON bits in the configuration register of the selected computing element. The state bits are also reset to 00 in the selected computing element when this switch is depressed.

Panel F

The controls and indicators on panel F permit storage selection, sense switch operation, and modification and monitoring of certain computing element registers.

Storage Data Indicators - These indicators display the contents of the storage address specified in the Instruction Address switches.

Storage Data Switches - These switches enable manual entry of data into an addressable storage location (as specified in the Instruction Address switches)

Instruction Address Indicators - Four registers of indicators (CE-1, CE-2, CE-3, and CE-4) are used to continuously display the contents of corresponding instruction address in the computing elements.

Instruction Address Switches - These switches enable manual selection of any addressable Local Store or Main Storage location. The Instruction Address switches are used in conjunction with the Set IC Switch to modify the instruction address of a selected computing element.

Sense Switches - Six sense switches (A-F) enable the operator to perform program sense switch operations. The settings of the sense switches are transferred upon the execution of a special read sense switch instruction.

Storage Switch - This switch enables the selection of a specified storage area (Main or Local) associated with a selected computing element to be addressed by the Instruction Address switches (located to the right of the Storage switch).

Panel G

The controls and indicators on panel G permit monitoring and control of various console and system operations.

Test Mode Indicator - This indicator indicates that the customer engineering panel within the console is operative.

NOTE: If the test mode indicator is on, notify the customer engineer before starting normal system operations.

I/O Interface Enable/Disable Switch - This switch is placed in the Disable position prior to turning system console power on or off. When turning power off place the switch in the Disable position, wait until the Disabled indicator is activated, and then remove power. When turning power on place the switch in the Disable position, turn on the power, wait until the Power Sequence Complete indicator is activated, and then place the Enable/Disable switch in the Enable position.

Disabled Indicator - This indicator is activated when the Enable/Disable switch is in the Disable position and the console is logically disconnected from the IOCE channels.

Lamp Test Switch (Rotary) - This is a 12-position rotary switch that enables the operator to test certain lights and indicators on the operator's control panel. The positions are:

1. Off
2. A1, B2, C3, and 4-7--Turns on corresponding characters in the mode of operation indicator.
3. Load-- Turns on the Load Key indicator.
4. Invalid Selection--Turns on corresponding indicator and the red lights in the mode of operation indicator.
5. Test Mode--Turns on corresponding indicator.

6. Enable--Turns on both of the I/O select Enable switch indicators.

Lamp Test Switch - Depressing this switch turns on the following indicators for testing:

1. Status
2. Alarms
3. Configuration
4. Storage Data
5. Instruction Address
6. CE Manual
7. CE Wait
8. Power sequence complete

NOTE: If any of the indicators associated with the Lamp Test switch or Lamp Test switch do not light, notify the customer engineer.

Address Compare Switch - This three-position switch is used in conjunction with the CE Select switch, Instruction Address switches, Storage Data switches, and the Address Compare-Enable switch. The switch positions are:

Stop - This position causes the selected computing element to enter the wait state at the end of an instruction that accesses the storage location specified in the Instruction Address switches.

Process - This position is the normal position of the Address Compare switch. Normal processing operations are performed with the switch in this position.

Loop - This position causes the selected computing element to loop between the addresses specified in the Instruction Address and Storage Data switches. The loop operation is program controlled and is initiated when the selected computing element accesses the address specified in the Instruction Address switches.

NOTE: The Stop and Loop positions are not conditioned until the Address Compare-Enable switch is depressed.

Address Compare-Enable Switch - Depressing this switch conditions the Stop and Loop positions of the Address Compare switch. Releasing this switch has the same effect as placing the Address Compare switch in the Process position.

Rate Switch - This switch is a two-position switch that operates in conjunction with the CE Select switch and the Start switch. The switch positions are:

Process - This position enables the selected computing element to operate at normal clock speed when the Start switch is depressed.

INSN Step - This position allows only one instruction step to be executed by the selected computing element for each depression of the Start switch. In this position, all instructions can be

executed and all pending not-masked interruptions can be handled. The selected computing element returns to the stopped state at the completion of the instruction.

Start Switch - Depressing this switch starts the selected computing element. If the switch is depressed after a normal stop operation, instruction processing continues as if no stop had occurred.

Console Reset Switch - Depressing this switch causes all console logic functions to be reset except for the following lights: Status, Alarm, Storage Data, Instruction Address, CE Manual, and CE Wait.

Buzzer Reset Switch - Depressing this switch resets the audible buzzer alarm.

Bell Reset Switch - Depressing this switch resets the audible bell alarm.

Set IC Switch - Depressing this switch transfers the contents of the Instruction Address switches into the instruction counter of the selected computing element.

Store Switch - Depressing this switch transfers the contents of the Storage Data switches into the storage word specified by the Storage switch and the Instruction Address switches.

Display Switch - Depressing this switch transfers the contents of a specified storage word into the Storage Data indicators. The storage word to be displayed is specified by the Storage switch and the Instruction Address switches.

Stop Switch - Depressing this switch causes one or all of the following three conditions:

1. The selected computing element is placed in the stop state without destroying the computing element's environmental status. Any instruction being executed when the Stop switch is depressed is completed before the selected computing element enters the stopped state.
2. If the current instruction causes a program interrupt, the program status word, associated with the selected computing element, is updated.
3. An I/O device completes its operation; however, I/O or external interrupts are not recognized.

Invalid Selection Indicator - This indicator indicates that an invalid or illegal storage location has been selected during a manual intervention. The indicator is turned off when a valid storage location is selected.

All Stop Switch - Depressing this switch causes all computing elements to enter the stopped state.

Panel H

The controls and indicators on panel H permit control and monitoring of storage and computing element selection, console power and IPL operations.

Main Storage Select Switch - This switch is used during initial program loading to select a specific storage element. When the Load switch is depressed, the Main Storage select switch setting is transferred to a selected computing element.

Power On Switch - Operating this switch initiates the power-on or power-off sequences. If the switch is depressed when console power is off, the console blowers are activated, the DC power supplies are sequenced on, and the power on switch indicator is turned on. The Power Check indicator is turned off and the Power Sequence Complete indicator is turned on when the last DC power supply is sequenced on.

Depressing the Power On switch when console power is on, causes the DC power supplies to sequence off, the console blowers to deactivate, the Power-On indicator to turn off, and the Power Sequence Complete indicator to turn off. The Power Check indicator is turned on when the last DC power supply is sequenced off.

Power Sequence Complete Indicator - This light indicates that the last DC power supply has been sequenced on during a power-on operation (power on-off switch to On position). The indicator is turned off when the last power supply is sequenced off during a power-down operation.

System Interlock - This device is a two-position key-controlled switch. A key must be inserted to turn the switch on. The key cannot be extracted until the switch is turned off. When the switch is off, the operation of certain manual controls is inhibited, preventing operator errors. A red light is turned on in the mode of operation indicator (located to the left of the Emergency Pull switch) when the switch is on. This notifies the operator that all manual controls are operative.

NOTE: The system interlock should never be on during normal system operation.

Load Unit Selection Switches - These three switches are used during initial program loading to select a specific channel and I/O unit address. The leftmost switch determines the channel address, and the remaining two switches select the I/O unit address. When the Load switch is depressed, the Load Unit switch settings are transferred to a selected computing element.

CE Select Switch - This switch enables the selection of a specific computing element (1, 2, 3 or 4).

Interrupt Switch - Depressing this switch enables the operator to perform a manual interrupt in system operations. A console interrupt signal is transferred to the selected computing element, causing bit

25 of the program status word to be set.

CE Manual Indicators - One of the four CE manual indicators is turned on when a corresponding computing element status indicator is turned on. These lights are on when a computing element is in the stopped state.

CE Wait Indicators - One of the four CE wait indicators is turned on when a corresponding computing element wait bit is a 1 in its associated program status word.

Load Switch - Depressing this switch initiates an initial program load operation. When the load operation starts, the selected computing element turns on a lamp within the Load switch. The switch is turned off by a signal from the selected computing element when the load operation is completed.

General Operating Procedures

The following paragraphs describe specific machine procedures performed by the system operator.

Starting Procedures

Operator's System Responsibility

The system operator is responsible for:

1. Turning on the system (if power has been off).
2. Initializing the system (manual IPL procedures in conjunction with the appropriate operating System).
3. Communicating with the system (through the Card Read Punch, 1052 Printer/Keyboard, Printer, and Console Indicators).
4. Making operator adjustments as required (to console and peripheral equipment.)
5. Performing certain operator trouble correction procedures.
6. Turning off the system as required.

Power On Procedure

The related controls and indicators are located on panels B, G, and H (Figure 8). The procedure for applying power to the system console is:

1. Make certain that the Console Power Mainline On indicator is on and the Enable/Disable switch is in the Disable position.
2. Depress the Power On switch and verify that the switch indicator light comes on.
3. Verify that the Power Check indicator is off and the Power Sequence Complete indicator is on.
4. Power is now sequenced on. Check the Console Power-Thermal

Check indicator to make certain it is off. If it is on, perform steps 5 and 6; otherwise, proceed with normal operations.

5. Depress the Thermal Reset switch two or three times.
6. If the Console Power-Thermal Check indicator is still on, notify the customer engineer.
7. Place the Enable/Disable switch in the Enable position and verify that the Disabled indicator is off.

Initial Program Loading

Initial Program Loading enables the operator to load new data into the system. The related controls and indicators are on panels G and H. The procedure is:

1. Select a computing element with the CE Select switch.
2. Select a Main Storage Element with the Main Storage Select switch.
3. Select a desired channel and I/O device address with the Load Unit switches.
4. Turn on the System Interlock.
5. Depress the Stop switch.
6. Depress the Load switch.

NOTE: The Load switch indicator should turn on and then off quickly. This indicates that the load operation is complete. If the Load switch indicator remains on, notify the customer engineer.

Audible Alarms

A bell and a buzzer are provided in the console for operator attention. Both are program controlled and can be reset by the bell reset and buzzer reset keys (Panel G), respectively.

Sense Switch Operation

If system operations require that certain sense switches (Panel F) be turned on, place the specified switch in the down position. Special program instructions then read and transfer the switch settings to the program.

Storage Modification

The contents of any addressable storage word can be modified by switches on panels F, G, and H. The procedure for modifying a storage word is:

1. Enter the desired data into the Storage Data switches.
2. Select Main Local storage with the Storage switch.
3. Enter the address of the storage word to be modified in the Instruction Address switches.
4. Select the desired computing element with the CE Select switch.
5. Turn on the key operated System Interlock.
6. Depress the Stop switch.
7. Depress the Store switch.
8. Depress the Display switch and check the Storage Data indicators to verify that correct data was stored.
9. Depress the Start switch to resume operations.
10. Turn off the key operated System Interlock.

NOTE: If an illegal storage word is selected, no data is displayed and the invalid selection light is turned on.

Storage Display

The contents of any addressable storage word can be displayed by controls and indicators locate/on panels F, G, and H. The procedure for storage display is:

1. Enter the address of the storage word to be displayed in the Instruction Address switches.
2. Select Main Local storage with the Storage switch.
3. Select the desired computing element with the CE Select switch.
4. Turn on the key operated System Interlock.
5. Depress the Stop switch.
6. Depress the Display switch.
7. The contents of the selected storage word are displayed in the Storage Data indicators.
8. Depress the Start switch to resume operations.
9. Turn off key operated System Interlock

NOTE: If an illegal storage word is selected, no data is displayed and the invalid selection light is turned on.

Modification of CE Configuration Register

A selected computing element configuration register can be modified

by the operator. The related controls and indicators are on panels E, G, and H. The modification procedure is:

1. Enter the desired computing element configuration in the Control CE switches.
2. Select the desired computing element with the CE Select switch.
3. Turn on the key operated System Interlock.
4. Depress the Stop switch.
5. Depress the Control CE-Activate switch.
6. Depress the Start switch to resume operations.
7. Turn off the key operated System Interlock.

Instruction Address Modification

The instruction address of a computing element can be modified by the operator. The related controls and indicators are on panels F, G, and H. The procedure is:

1. Select the desired computing element with the CE Select switch.
2. Enter the modification data in the Instruction Address switches.
3. Turn on the key operated System Interlock.
4. Depress the Stop switch.
5. Depress the Set IC switch.
6. The modified address is displayed in the instruction address indicators corresponding to the selected computing element.
7. Depress the Start switch to restart the program from the modified address.
8. Turn off the key operated System Interlock.

I/O Device Switching

The console-connected IBM 1052 Printer/Keyboard, IBM 2540 Card Read Punch, and the IBM 1403 Printer can be connected to any one of the three Input/Output Control Element (IOCE) interfaces. The procedure is:

1. Select the desired IOCE interfaces with the I/O Select switches (Panel E).
2. Depress the associated I/O Select-Enable switch. The switch indicator turns on when the switching operation is complete.

Emergency Power-Off

The procedure for performing an Emergency Power-Off (EPO) operation is:

1. Pull out the red Emergency Pull switch located at the top right corner of the operator's control panel.
2. When the condition causing the EPO operation is corrected, notify the customer engineer to reset the Emergency Pull switch.

NOTE: After the Emergency Pull switch is reset, power is automatically sequenced up on all elements having their power-control switches in the ON position.

Operator Control Back-up

All critical console functions are duplicated elsewhere in the system (Table 2). These controls and indicators should be used only when the system console is not available.

Table 2. Operator Control Backup (System Console)

System Console Indicator (I) or Control (C)		Indicator or Control Backup*						
Type	Name	CE	PAM	TCU	SCU	SE	IOCE	PAM** 1052
I	Mode of Operation							X
C	Master Power Off***	X	X	X	X	X	X	
I	Status	X	X	X	X	X	X	
I	Alarms (Fault)	X	X	X	X	X	X	
I	Alarms (Audible)							X
I	Configuration							X
I,C	Storage Data	X						
I,C	Instruction Address	X						
C	Set IC	X						
C	Store	X						
C	Display	X						
C	Start	X						
C	Stop	X						
C	Control CE	X						
C	Address Compare	X						
C	Rate	X						
C	Load Unit	X						
C	Load	X						
C	Main Storage Select	X						
C	Interrupt	X						
C	Sense Switches							X
I	Printer and Punch							X
C	Reader							X
I,C	Console Connected 1052							X

* CE - Computing Element, PAM - Peripheral Adapter Module, TCU - Tape Control Unit, SCU - Storage Control Unit, SE - Storage Element, IOCE - Input/Output Control Unit, PAM 1052 - PAM-connected 1052.

** Hard copy printout and keyboard operation possible with the PAM-connected 1052 and proper programming.

*** Element master power off turns down all power in an element; the Emergency Pull (System Console) removes all system power. Emergency Pull is always operable.

IBM 9020E DISPLAY CHANNEL PROCESSOR

9020E SYSTEM CONFIGURATION

The basic structure of an IBM 9020E Display Channel Processor consists of:

- IBM 7251-09 Storage Elements
- IBM 7201-02 Computing Elements
- IBM 7231-02 Input/Output Control Elements
- IBM 7265-03 Configuration Console
- IBM 2701-01 Data Adapter Units
- IBM 7289-04 Display Elements
- IBM 2803-01 Tape Control Units
- Assorted I/O devices attached to and operated through their respective control units

All 9020E Elements are constructed as self contained units, with each having its own power supply. The 9020E Display Channel Processor (DCP) configuration is shown in Figure 9.

System Elements Common to 9020D/E Systems

The following elements are common to 9020D/E Systems:

- IBM 7251-09 Storage Elements
- IBM 7201-02 Computing Elements
- IBM 7231-02 Input/Output Control Elements
- IBM 2803-01 Tape Control Units

Additional similarity, exists in the assortment of I/O devices attached to the system. Refer to Figures 1 and 9 to identify the similarities.

The following paragraphs discuss the 9020E System elements that differ from the 9020D System elements.

IBM 7265-03 Configuration Console

The IBM 7265-03 Configuration Console (CC) provides monitoring and controls for the 9020E System. In addition it provides configuration and fault reporting paths for Display Generators (DG), Radar Keyboard Multiplexors (RKM) and the IBM 2701 DAUs. A programmed data path is also provided to the SMMC. The CC is divided into two major functional areas:

- System Console Function
- Error Reporting and Reconfiguration Function

The System Console function is similar to that provided by the IBM 7265-02 System Console for the 9020D System. Refer to System Console discussion for additional details. The function is provided by direct connection to various elements, units, and by an internal

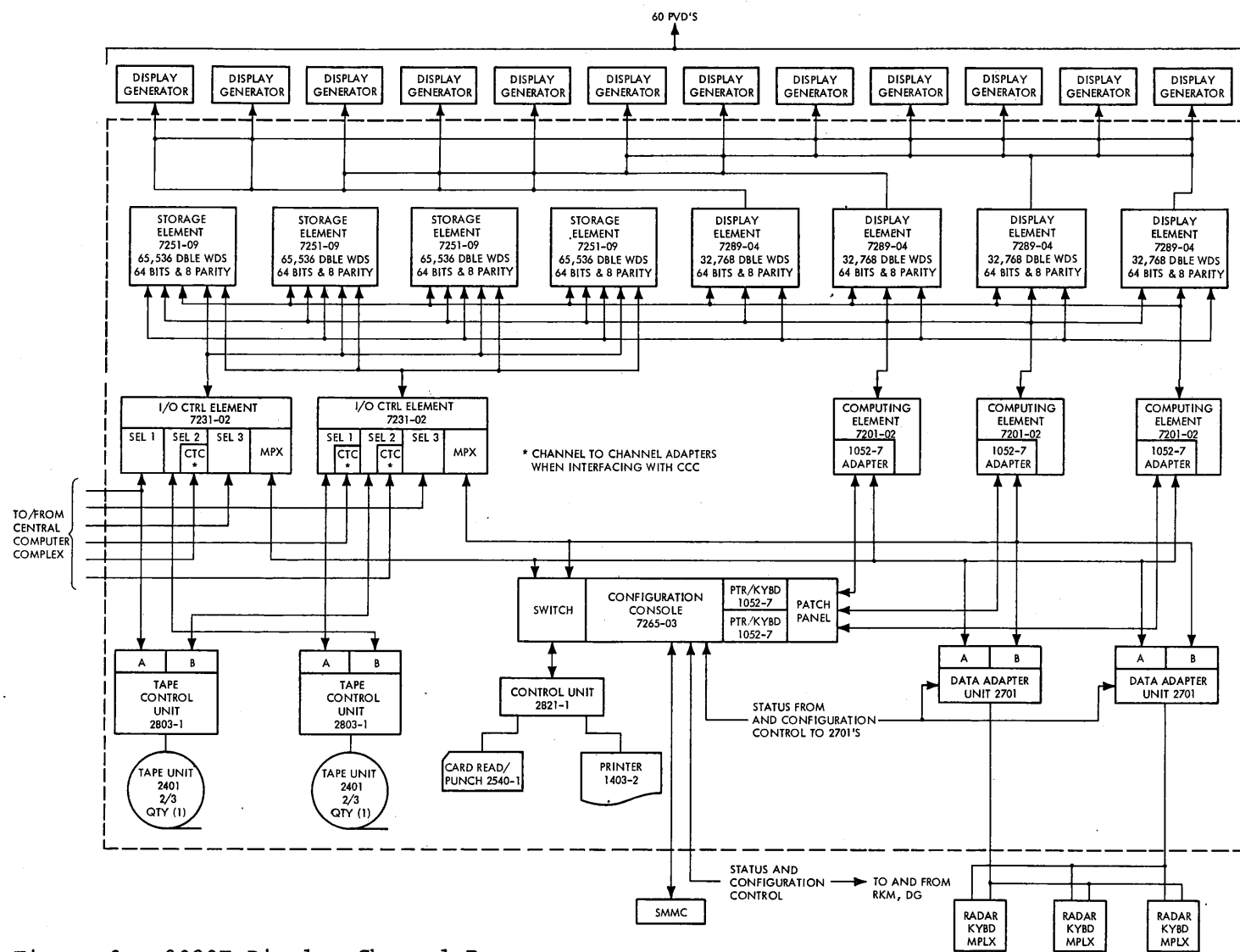


Figure 9. 9020E Display Channel Processor

System Console Control Unit (SCCU). The SCCU supports programmed I/O operations for updating indicators, reading switches, and transferring data to the SMMC.

The Error Reporting and Reconfiguration Function is provided by duplexed Reconfiguration Control Units (RCU). Each RCU is functionally identical and each can perform the total reconfiguration task. The RCU's are separately powered and capable of being independently maintained. Each RCU is attached to two (expandable to three) IOCE multiplex channels and connections are established by configuration control from the controlling CE.

IBM 2701-01 Data Adapter Unit

The IBM 2701-01 Data Adapter Unit (DAU) is a self contained self powered unit which interfaces Radar Keyboard Multiplexors (RKM) to the IBM DCP. All necessary bit-byte conversion, data control, and interface matching is accomplished by the three functional sections of the DAU: The Two Processor Switch; the Transmission Interface Converter; and the Modified Parallel Data Adapter. These functional sections operate together to provide a single complete path for the IOCE/RKM operation.

The DAU functions as a control unit for the RKMs. To the system the DAU functions and responds the same as any 9020 control unit, (see 9020D and 9020E System Principles of Operation manual, Form A27-2734 for additional I/O architecture). Commands and address are passed from IOCE through the Two Processor Switch, Transmission Interface Converter, Modified Parallel Data Adapter and out to the RKM. The DAU once selected, controls the data flow between IOCE and RKM as two independent functions. The DAU accumulates check and sense information and transfers it to the system upon request or during status time.

Each DAU can interface up to five RKMs. This interface consists of a Data Bus Out to the RKM, a Data Bus In to the 2701, an Address Bus Out to the RKM, and the control lines necessary for proper interface sequencing. The interface operates in a demand/response mode and contains both multiplex and simplex lines. Although the DAU can have five devices attached to it, it cannot operate these devices in a multiplex environment. It must complete an operation with one RKM before initiating an operation with another.

The data paths provided to and from the DAU/RKM are one byte each (8 data bits, 1 parity bit). The ability to buffer two bytes of data is provided in the Modified Parallel Data Adapter to make the RKM disconnect sequence compatible with the IOCE disconnect sequence.

The RKM does not share the same repertoire of commands as the DAU. Since the commands are different in both format and function, the DAU must generate compatible RKM commands. The DAU reformats the 8-bit IOCE/DAU command to form the RKM command.

Each DAU has a Two Processor Switch (TPS) which is used to

connect it to two IOCEs. The TPS is under configuration control and receives its enable/disable signals from the Configuration Console.

IBM 7289-04 Display Element

The IBM 7289-04 Display Element (DE) is a self contained self powered unit. The DE contains core storage, request priority controls, and refresh scanning controls capable of handling four Display Generators (DGs) simultaneously. Each DE also contains battery backup power and a maintenance panel.

Each DE contains two 131,072 byte Basic Storage Modules (designated as Even BSM and Odd BSM) for a total of 262,144 bytes. A byte consists of eight data bits and one parity bit. Data is transferred to and from storage in doublewords (a doubleword is 8 bytes). The BSM cycle time is 800-ns; however, the two BSMs can be accessed so that, using two way interleaving, a doubleword can be obtained every 400-ns.

Each DE can be accessed from any of four 7201-02s (CEs) and twenty-four Character Vector Generators. The honoring of requests is controlled by the priority circuitry and the Configuration Control Register (CCR). The CCR determines which CEs and CVGs will be scanned by the priority logic.

Each DE contains a storage protect buffer which provides a protection key for each contiguous block of 2048 bytes of storage. These keys can be set and inspected by executing the Set Storage Key and Insert Storage Key instructions respectively.

FORMATS AND CODES

Instruction and Data Formats

9020E System information relationships, data, and operation code formats are shown in Figure 2.

Code Conversion Charts

The Charts and procedures for binary, hexadecimal, decimal, fraction, and number conversion are shown in Figure 3. The EBCDIC codes are shown in Figure 4; the ASCII-8 codes, in Figure 5.

Programming Considerations, General

Information contained in the 9020D System discussion of information handling, instruction format, and main storage addressing is also applicable to the 9020E programming considerations discussion.

OPERATOR CONTROLLED EQUIPMENT

The IBM 9020E System has been designed so that a minimum of operator action is required for system operation. There are five pieces of

equipment that the operator can actively control: Configuration Console, IBM 2540 Card/Punch, IBM 1403 Printer, IBM 1052 Printer/Keyboard, and IBM Magnetic Tape Unit. The following sections of this manual contain information required to operate this equipment. More detailed information can be found in the IBM 9020D and 9020E System Principles of Operation manual, Form A27-2434.

CONFIGURATION CONSOLE

The IBM 7265-03 Configuration Console (Figure 10) provides central monitoring and controlling capabilities for the IBM 9020E System. Functionally, the console is divided into two major functional parts: the system console function; and the error reporting and reconfiguration function. Refer to the IBM 7265-03 Configuration Console discussion for additional details.

Control and Indicators

The controls and indicators on the Configuration Console operator's panel are located on six panels designated A through F (See Figure 11). The operational environment for the various Configuration Console switches is given in Table 1.

NOTE: Certain controls on the operator's control panel are interlocked by the key-operated System Interlock switch (lower, right corner on Figure 11). This switch must be on to enable the interlocked controls which are indicated by an asterisk (*) on Table 1.

Panel A

The controls and indicators on Panel A provide the operator with system power indications and control as well as individual controls and indicators for each control unit located in the Configuration Console.

Emergency Pull Switch - Pulling out on this switch causes all IBM 9020E System power to be removed within two seconds. However, power is still present within the prime power compartments of each system element.

NOTE: The Emergency Pull switch is a mechanical latch type switch that must be manually reset after it is operated. A customer engineer must perform the reset task. After the switch is reset, power automatically sequences up on all units having their power switch in the On position.

System Power Indicators - Summarizes status of system power.

Standby - Indicates when the prime AC input power to the system is being supplied by the standby source.

Battery - Indicates when one or more of the system elements has switched to battery power. The indicator is turned off when the element on battery power switches back to main or standby power.

The indicator functions regardless of console power status.

Console Power Indicators - Summarizes status of Configuration Console power.

Mainline On - Indicates when either of the main console circuits breakers is on. The indicator functions when either main or standby prime AC is supplied to the console. Furthermore, the indicator is independent of the all Power On/Off switch operations.

Power Check - Indicates that one or more of the following conditions exist in the System Console Control Unit power system:

1. A catastrophic power failure has occurred.
2. A temperature in excess of 130°F exists in the SCCU.
3. A normal power-off operation has taken place (Power On/Off switch to the Off position).

NOTE: If the Power Check indicator is on because of conditions 1 or 2 notify the customer engineer.

Thermal Check - Indicates that the SCCU operating temperature has exceeded 120°F. The indicator can be turned off by depressing the Thermal Reset switch.

Thermal Reset Switch - Depressing this switch turns off the Thermal Check indicator when the SCCU operating temperature is below 120°F.

NOTE: If the Thermal Check indicator is not turned off after having depressed the Thermal Reset switch, the customer engineer should be notified.

System Console Power Supply Select Switch - This switch is used for selecting one of two (B or C) SCCU power supply sets.

System Console Power On/Off Switch - Operation of this switch initiates the power-on or power-off sequences for the System Console portion of the CC. Placing the Power On/Off switch in the On-position activates the elements blowers, and sequences the dc power supplies. The Power Check indicator is turned off when the last dc power supply has sequenced on. The Power Sequence Complete indicator is turned on when the last dc power supply has sequenced on.

Placing the Power On/Off switch, in the Off-position causes the dc power supplies to sequence off, deactivate the elements blowers, turn off the Power Sequence Complete indicator, and turn on the Power Check indicator when the last dc power supply has sequenced off.

System Console I/O Interface Enable/Disable Switch - This switch provides the capability of logically disconnecting the SCCU from the IOCE. The function is used when it is necessary to change power status, either on, off or switching to the opposite set of duplex power supplies.

When placed in the Disable position, the switch action causes

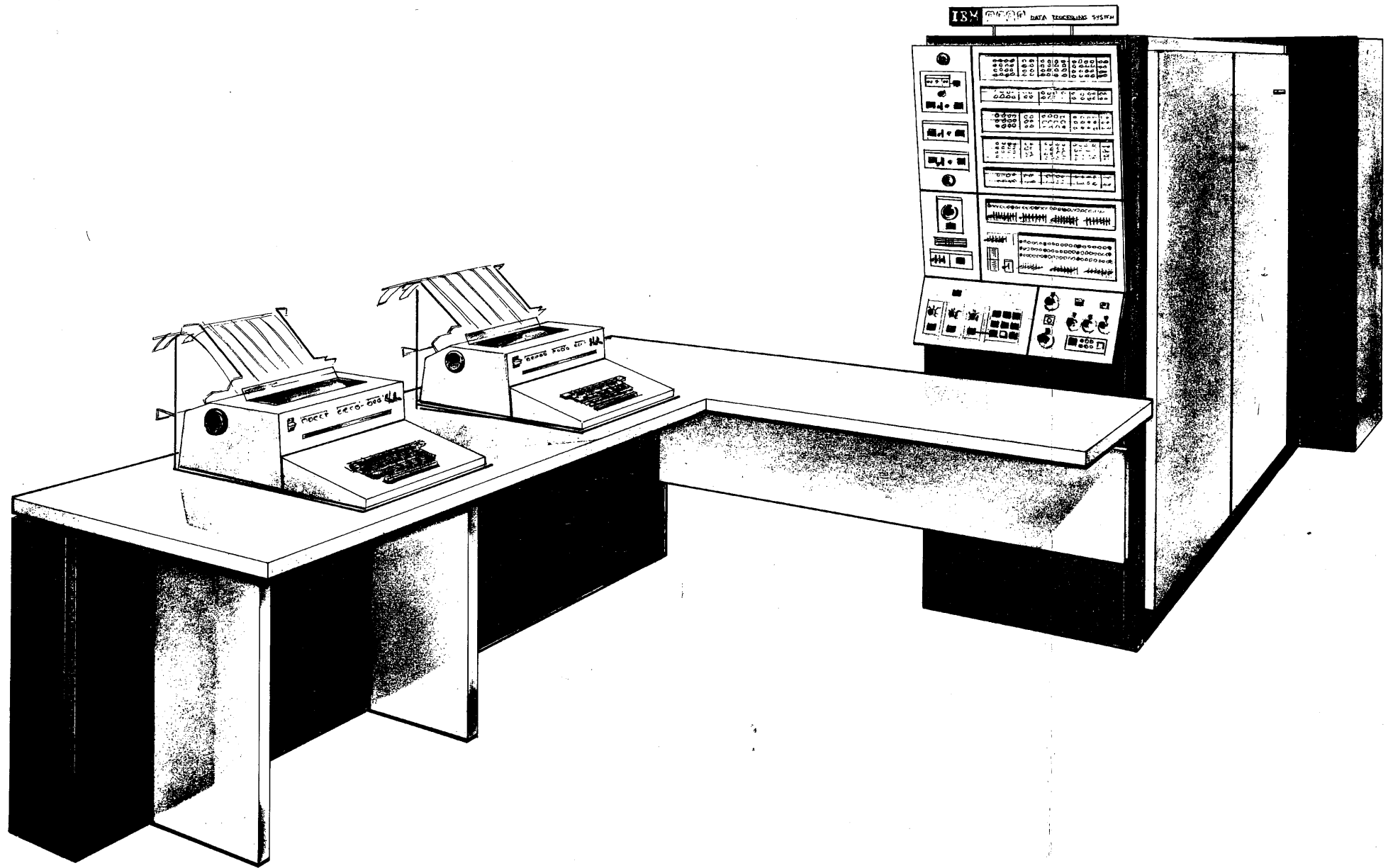


Figure 10. Configuration Console

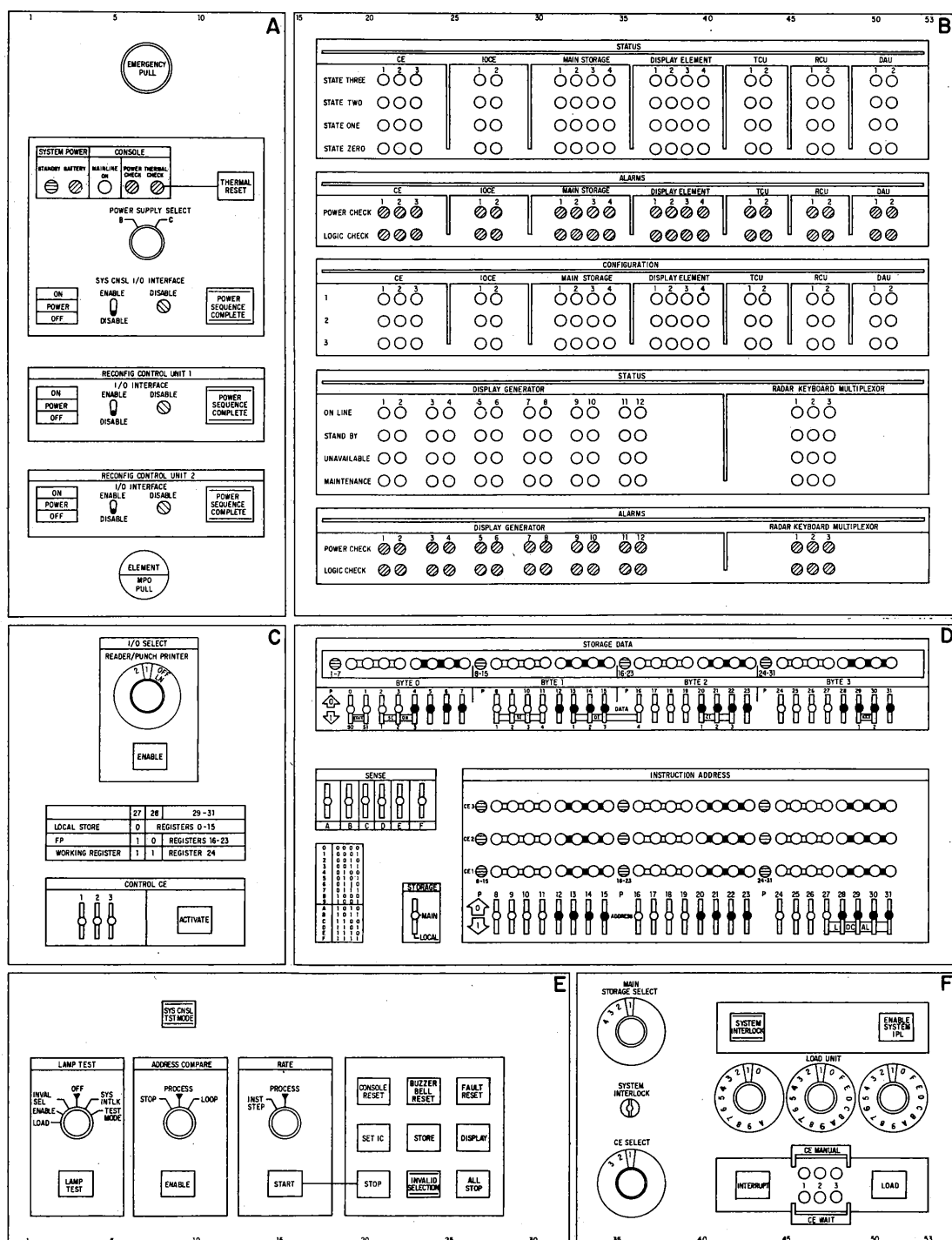


Figure 11. 9020E Configuration Console Operator's Panel

the SCCU to logically disconnect from the IOCE's and when disconnected, turns on the Disabled Indicator.

When placed in the Enable position the opposite sequence occurs: The SCCU is logically connected to the IOCE and when connected, the Disabled indicators is turned off.

Reconfiguration Control Unit Power Controls and Indicators - A Power ON-OFF switch, Power Sequence Complete indicator, I/O Interface Enable-Disable Switch and Disabled Indicator are provided for each of the two RCU's contained in the Configuration Console. The functions provided are the same as those provided for the corresponding SCCU controls and indicators with the exception that the controls are interlocked by State control. The Disable function of the I/O interface Enable-Disable switch is functional only when the RCU is in State Zero not test. The power off function of the Power ON-OFF Switch is functional only when the RCU is in State Zero and has either been placed in Test mode by maintenance personnel or has been disabled by the I/O Interface Enable-Disable switch. In the later case the Disabled indicator must be on.

Element Master Power Off Pull Switch - Pulling out this switch causes the power to be removed from all Configuration Console circuits and cabling outside the prime power compartments. The switch is not interlocked by any other condition and activating it may result in data loss. The switch is a mechanical latch type switch which must be reset by a customer engineer.

Panel B

The indicators on Panel B permit monitoring of the status, alarm condition, and system configuration of the IBM 9020E System Elements (CE's, IOCE's, SEs, DEs, TCUs, RCUs, and DAUs.) Other indicators permit monitoring of the status and alarm activity of the non-IBM elements (Display Generators and Radar Keyboard Multiplexors.)

Status Indicators - Four indicators are used to indicate the unit status (state 0-3) for each of the following:

1. Computing Elements
2. Input/Output Control Elements
3. Storage Elements
4. Display Elements
5. Tape Control Units
6. Reconfiguration Control Units
7. Data Adapter Units

Only one of the four state indicators is on for an element at a given time. No State indicator will be on for any element having power down.

Alarm Indicators - Two indicators are used to indicate a power or logic malfunction in each of the elements mentioned in the preceeding paragraph. The alarm indicators are designated as:

Power Check - These indicators indicate that one or more of the following conditions exist in the element causing the alarm:

1. A catastrophic power failure exists.
2. An over-temperature condition exists.
3. A normal power-off condition exists.

Logic Check - These indicators indicate that a system element has detected its own logic check condition. If even parity is transferred from the console to a computing element, that computing element turns on its corresponding Logic Check indicator.

Configuration Indicators - Three registers of indicators (1,2, and 3) are used to indicate the system configuration. These registers are program controlled and remain on until they are updated by the program or reset by the Console Reset switch.

Status Indicators (Non-IBM Elements) - Four indicators for each of the display subsystem Display Generators (DG) and Radar Keyboard Multiplexors (RKM) are provided on Panel B of the Configuration Console operators panel. These indicators designated On Line, Standby, Unavailable, and Maintenance are program addressable and used to display the status of each of the DG's and RKM's. Once set, the indicators remain on until updated by the program or reset by depressing the Console Reset pushbutton.

The status indicator registers are updated sequentially by unit after the console control unit has accepted address (01) followed by a command byte.

Alarm Indicators (Non-IBM Elements) - Two indicators for each display subsystem DG and RKM are provided on the Configuration Console to indicate Power Check and Logic Check. These indicators are program addressable and normally set when an error report from DG or RKM has indicated a fault condition to the program.

The alarm indicators are updated sequentially by unit after the console control unit accepts address (01) followed by a command byte.

The indicators remain on until either turned off by the program or reset by depressing the Console Reset switch.

Panel C

The controls on panel C permit I/O selection and limited Computing Element configuration control.

I/O Select Switch - Assigns Reader/Punch Printer to one of two channels (1 or 2) or off line for maintenance.

Enable Switch (Reader/Punch Printer) - This switch conditions the selection made by the I/O Select switch. An indicator within the switch is activated upon completion of the switching operation and remains on until the I/O Select switch setting is changed. Returning the I/O Select switch to the original position causes the switch indica-

tor to be activated.

Local Storage Map - The Local Store map for the 9020E Configuration Console is shown in Figure 11. The map indicates Address switch settings required to display General Registers, Floating Point Registers, or the Working Registers.

When bit 27 is set to zero, bits 28-31 are used to select one of the sixteen General Registers in Local Storage. The registers (0-15) are addressable by binary settings of 0000 through 1111 respectively.

Setting the Address switches bits 27 to 1 and 28 to 0 selects the Floating Point Registers. The eight (16-23) Floating Point Registers are addressed by bits 29-31 with the binary setting 000 through 111 respectively. When bits 27 and 28 of the Address switches are both set to one, the Working Register is selected. The contents of the remainder of the Address switches are not used for this operation.

Control CE Switches - One switch is provided for each Computing Element to allow manual updating of the SCON bits in the Configuration Register. This enables a minimum amount of operator control of the Computing Element configuration. These switches are not conditioned until the control CE-Activate switch is depressed.

Control CE-Activate Switch - Depressing this switch transfers the setting of the control CE switches to the SCON bits in the Configuration Register of the selected Computing Element. The state bits are also reset to 00 in the selected Computing Element when this switch is depressed.

Panel D

The controls and indicators on panel D permit storage selection, sense switch operation, and modification and monitoring of certain computing element registers.

Storage Data Indicators - These indicators display the contents of the storage address specified in the Instruction Address switches.

Storage Data Switches - These switches enable manual entry of data into an addressable storage location (as specified in the Instruction Address switches.)

Sense Switches - Six sense switches (A-F) enable the operator to perform program sense switch operations. The settings of the sense switches are transferred upon the execution of a special Read Sense Switch instruction.

Storage Switch - This switch enables the selection of a specific storage area (Main or Local) associated with a selected computing element to be addressed by the Instruction Address switches.

Instruction Address Indicators - Three registers of indicators (CE1, CE2, and CE3) are used to continuously display the contents of corre-

sponding instruction address in the computing elements.

Instruction Address Switches - These switches enable manual selection of any addressable local store or main storage location. The Instruction Address switches are used in conjunction with the Set IC switch to modify the instruction address of a selected computing element.

Panel E

The controls and indicators on panel E permit monitoring and control of the various console and system operations.

System Console Test Mode Indicator - This indicator indicates that the customer engineering panel for the SCCU within the console is operative.

NOTE: If the System Console Test Mode indicator is on, notify the customer engineer before starting normal system operations.

Lamp Test Switch (Rotary) - This switch is a six-position rotary switch that enables the operator to test certain lights and indicators on the operators panel. The positions are:

1. Off
2. System Interlock - Turns on corresponding indicator.
3. Test Mode - Turns on corresponding indicator.
4. Invalid Selection - Turns on corresponding indicator.
5. Enable - Turns on both of the I/O Select Enable switch indicators.
6. Load - Turns on the Load switch indicator.

Lamp Test Switch - Depressing this switch turns on the following indicators for testing:

1. Status
2. Alarms
3. Configuration
4. Storage data
5. Instruction address
6. CE manual
7. CE wait
8. Power-On switch indicator
9. Power sequence complete

NOTE: If any of the indicators associated with the Lamp Test switches do not light, notify the customer engineer.

Address Compare Switch - This three-position switch is used in conjunction with the CE Select switch, Instruction Address switches, Storage Data switches, and the Address Compare-Enable switch. The switch positions are:

Stop - This position causes the selected computing element to enter the wait state at the end of an instruction that accesses the

storage location specified in the Instruction Address switches.

Process - This position is the normal position of the Address Compare switch. Normal processing operations are performed with the switch in this position.

Loop - This position causes the selected computing element to loop between the addresses specified in the instruction address and storage data switches. The loop operation is program controlled and is initiated when the selected computing element accesses the address specified in the Instruction Address switches.

NOTE: The Stop and Loop positions are not conditioned until the Address Compare-Enable switch is depressed.

Address Compare-Enable Switch - Depressing this switch conditions the Stop and Loop positions of the Address Compare switch. Releasing this switch has the same effect as placing the Address Compare switch in the Process position.

Rate Switch - This switch is a two-position switch that operates in conjunction with the CE Select switch and the Start switch. The switch positions are:

Process - This position enables the selected computing element to operate at normal clock speed when the Start switch is depressed.

INST Step - This position allows only one instruction step to be executed by the selected computing element for each depression of the Start switch. In this position, all instructions can be executed and all pending not-masked interruptions can be handled. The selected computing element returns to the stopped state at the completion of the instruction.

Start Switch - Depressing this switch starts the selected computing element. If the switch is depressed after a normal stop operation, instruction processing continues as if no stop had occurred.

Console Reset Switch - Depressing this switch causes all console logic functions to be reset except for the following indicators: status, alarm, storage data, instruction address, CE manual and CE wait.

Buzzer/Bell Reset Switch - Depressing this switch resets both the buzzer and bell audible alarms.

Fault Reset Switch - Depressing this switch will turn off the SMMC Fault signal.

Set IC Switch - Depressing this switch transfers the contents of the Instruction Address switches into the instruction counter of the selected computing element.

Store Switch - Depressing this switch transfers the contents of the Storage Data switches into the storage word specified by the Storage

switch and the Instruction Address switches.

Display Switch - Depressing this switch transfers the contents of a specified storage word into the storage data indicators. The storage word to be displayed is specified by the Storage switch and the instruction Address switches.

Stop Switch - Depressing this switch causes one of all of the following three conditions:

1. The selected computing element is placed in the stop state without destroying the computing element's environmental status. Any instruction being executed when the stop switch is depressed is completed before the selected computing element enters the stopped state.
2. If the current instruction causes a program interrupt, the program status word, associated with the selected computing element, is updated.
3. An I/O device completes its operation; however, I/O or external interrupts are not recognized.

Invalid Selection Indicator - This indicator indicates that an invalid or illegal storage location has been selected during a manual intervention. The indicator is turned off when a valid storage location is selected.

All Stop Switch - Depressing this switch causes all computing elements to enter the stopped state.

Panel F

The controls and indicators on panel F permit control and monitoring of storage and computing element selection, console power, and IPL operations.

Main Storage Select Switch - This switch is used during initial program loading to select a specific storage element. When the Load switch is depressed, the Main Storage Select switch setting is transferred to a selected computing element.

System Interlock Indicator - This indicator is activated when the System Interlock switch is turned on.

Enable System IPL - This switch, when held depressed during an IPL causes a system IPL to be initiated. When not used, depressing the Load switch initiates a subsystem IPL operation.

System Interlock Switch - This device is a two position key-controlled switch. A key must be inserted to turn the switch on. The System Interlock indicator is activated whenever the System Interlock switch is turned on. The key cannot be extracted until the switch is turned off. When the switch is off, the operation of certain manual controls is inhibited, preventing operator errors.

NOTE: The System Interlock should never be on during normal system operation.

Load Unit Selection Switches - These three switches are used during initial program loading to select a specific channel and I/O unit address. The leftmost switch determines the channel address, and the remaining two switches select the I/O unit address. When the Load switch is depressed, the Load Unit switch settings are transferred to a selected computing element.

CE Select Switch - This switch enables the selection of a specific computing element (1, 2, or 3).

Interrupt Switch - Depressing this switch enables the operator to perform a manual interrupt in system operations. A console interrupt signal is transferred to the selected computing element, causing bit 25 of the program status word to be set.

CE Manual Indicators - One of the three CE Manual indicators is turned on when a corresponding element status indicator is turned on. These indicators are on when a computing element is in the stopped state.

CE Wait Indicators - One of the three CE Wait indicators is turned on when a corresponding computing element wait bit is a 1 in its associated program status word.

Load Switch - Depressing this switch initiates either a subsystem or system initial program load operation. When a system IPL is desired, the Enable System IPL switch is held depressed while pushing the Load switch. Depressing the Load switch alone initiates a subsystem IPL operation provided the selected CE is in State One or State Zero not test. When the load operation starts, the selected computing element turns on a light within the Load switch. The switch indicator is turned off by a signal from the selected computing element when the load operation is completed.

General Operating Procedures

There are several important operator intervention operations associated with the control of an active system that may be initiated from the Configuration Console. These functions include Initial Program Loading, manual entry of information into the active system, and manual switching of I/O equipment.

Power On Procedure

The related controls and indicators are located on panel A. The procedure for applying power to the System Console Control Unit is:

1. Make certain that the console power-mainline on indicator is on and the Enable-Disable switch is in the Disable position.
2. Place the Power On-Off switch in the On-position.
3. Verify that the Power Check indicator is turned off and

- the Power Sequence Complete indicator is turned on.
4. Power is now sequenced on. Check the console Thermal Check indicator to make certain it is off. If it is on perform steps 5 and 6, otherwise proceed to step 7.
 5. Depress the Thermal Reset switch several times.
 6. If the Thermal Check indicator remains on, notify a customer engineer.
 7. Place the I/O Interface Enable-Disable switch in the Enable position and verify that the Disabled indicator is turned off.

Initial Program Loading

A subsystem or system IPL may be performed from the Configuration Console. The manual controls for Initial Program Load (IPL) are located on Panel F of the CC operators panel. These controls include the CE Select switch, Main Storage Select switch, Load Unit Select switch, Enable System IPL switch, Load switch, and the System Interlock key switch.

The procedure for initiating a subsystem IPL from the Configuration Console is as follows:

1. Select a CE using the CE Select switch.
2. Select a Main Storage Element using the Main Storage Select switch.
3. Select the address of an I/O device by using the Load Unit Select switches.
4. Turn on the key operated System Interlock.
5. Depress the Load switch.
6. Turn off the key operated System Interlock.

The indicator contained in the Load switch will turn on when the IPL sequence is initiated and will remain on until the IPL is complete. If a fault condition should occur during the IPL sequence, the Load pushbutton indicator will remain on.

NOTE: A subsystem IPL is effective only when the selected CE is in State One or State Zero with the test switch off.

The procedure for a System IPL is identical to that described for a subsystem IPL with the following exception. After turning on the System Interlock switch, the Enable System IPL switch must be depressed and held. Depressing the Load (with the Enable System IPL switch held depressed), will then initiate a system IPL.

Audible Alarms

A bell and a buzzer are provided in the Configuration Console for operator attention. Both are program controlled and can be reset by the Buzzer/Bell Reset (Panel E).

Manual Entry of Information or Display

There are several methods for manual entry of information into the active system. These include using the IBM 1052-07 Printer Keyboard,

sense switches, storage modification or display, modification of the CE Configuration Registers and modification of the CE Instruction Counter.

Printer Keyboards

Printer Keyboards (IBM 1052-07) are located at the Configuration Console for data entry. Printer Keyboards enter data to an IOCE through adapters housed in a CE (IBM 7201-02). For flexibility, a patch panel at the Configuration console allows the Printer Keyboards to be electrically interchanged with each other.

Sense Switch Entry

The console has six sense switches (as shown on Panel D), which can be read into storage by program means through one of the interconnected IOCEs. If system operations require that certain Sense switches be turned on, place the specified switch in the down position. When the Read Sense Switch Command is accepted by the console, the contents of all six sense switches are transferred to the requesting IOCE.

Storage Modification

The contents of a selected storage word in an SE or De may be modified through the use of the CE Select switch, Storage Data switches, Address switches, Storage Select switch, and the Store switch. The procedure for storage modification from the Configuration Console is as follows:

1. Select the desired CE using the CE Select switch.
2. Enter data in Storage Data Switches. Correct byte parity (odd) is automatically assigned.
3. Enter storage address in the Address switches. Correct byte parity (odd) is automatically assigned.
4. Select Main or Local storage using Storage Select switch.
5. Turn on the key operated System Interlock.
6. Depress the Stop switch.
7. Depress the Store switch.
8. Turn off the key operated System Interlock.

Storage Display

The contents of a selected storage word may be displayed in a similar manner. The procedure for display of storage at the Configuration Console is as follows:

1. Select a CE using the CE Select switch.
2. Enter storage word address in the Address switches. Correct byte parity (odd) is automatically assigned.
3. Select Main or Local storage using the Storage Select switch.
4. Turn on the key operated Interlock.
5. Depress Stop switch.
6. Depress Display switch.
7. Turn off the key operated System Interlock.

If an invalid storage address for the selected CE is placed in the Address switches, the store or display operation will not be performed. The Invalid Selection indicator will be turned on and remain

on until a valid selection is made. An invalid selection can be caused by attempting to reference an SE or DE which is either not operational (power off), or not configured to the selected CE, or which represents a logical address range not assigned to a range of physical addresses by the CE's Address Translation Register (ATR).

Display of Information from Local Storage

To assist the operator in setting up the Address switches for displaying information from local storage, a map of LS is provided on the Configuration Console. The map, indicates Address switch settings required to display a General Purpose Register, a Floating Point Register, or the Working Register.

When bit 27 is set to zero, bits 28-31 are used to select one of the sixteen General Purpose Registers in local storage. The registers (0-15) are addressed by binary setting of 0000 through 1111 respectively.

Setting Address switch bit 27 to 1 and 28 to 0, selects the Floating Point Registers. The eight (16-23) Floating Point Registers are addressed by bits 29-31 with binary settings 000 through 111 respectively.

When bits 27 and 28 of the Address switches are set to 11, the Working Register is addressed. The contents of the remaining bit positions in the Address switches are not used for this operation.

Modification of CE Configuration Control Register (CCR)

The controls for modification of the selected CE's Configuration Control Register (CCR) are located on Panels C, E and F of the operators panel. The procedure for modification of the CE Configuration Control Register is as follows:

1. Set the desired configuration for the SCON bits in the Control CE switches. An odd parity bit will automatically be assigned.
2. Select the desired CE using the CE Select.
3. Turn on the key operated System Interlock.
4. Depress the Stop switch.
5. Depress the Control CE Activate switch. The contents of the Control CE switches will be set in the selected CE's CCR and the associated State bits will be reset to 00.
6. Turn off the key operated System Interlock.

Modification of CE Instruction Counter

The controls for modification of the CE Instruction Counter (Instruction Address) are located on Panels D, E, and F. The controls required are the Address switches, Set IC and the CE Select switch. The procedure is as follows:

1. Select a CE with the CE Select switch.
2. Set the desired contents of the IC in the Address switches.

3. Turn on the key operated System Interlock.
4. Depress Stop switch.
5. Depress the Set IC switch. The address will appear in the selected CE's Instruction Address indicators.
6. Turn off the key operated System Interlock.

Modification of an Instruction Address may be used to branch to a particular section of a program or to execute a particular instruction just stored.

I/O Switching

A rotary switch and an associated Enable pushbutton switch positioned on Panel C provide the operator with the ability to connect the IBM 2821 Control Unit to any one of the available IOCE's. The switching is accomplished by associated logic when the Enable switch is depressed. When the connection is established, an indicator behind the Enable switch is turned on.

The interconnected I/O devices are independently program addressable. The unit addresses are as follows:

Card Reader	03
Card Punch	04
Printer	05

If selection of one of these I/O devices is attempted through an IOCE not connected by the I/O Select switch, Condition Code 3 (device not operational is returned.)

Emergency Power Off

The procedure for performing an emergency power-off (EPO) operation is:

1. Pull out the red Emergency Pull switch located at the top left corner of the operator's control panel.
2. When the condition causing the EPO condition is corrected, notify the customer engineer to reset the Emergency Pull switch.

NOTE: After the Emergency Pull switch is reset, power is automatically sequenced up on all elements having their power-control switches in the On position.

Operator Control Back-Up

All critical System Console functions are duplicated elsewhere in the system (Table 3). These controls and indicators are used when the System Console portion of the Configuration Console is not available.

Table 3. Operator Control Backup (Configuration Console)

Indicator or Control	Indicator or Control Back Up		
	CE	CE 1052	ALL 9020E DISPLAY MAJOR ELEMENTS UNITS
9020 E System EPO *			
9020 E Status			X
9020 E Alarms (Faults)			X
Display Unit Status	X Hard Copy		X
Display Unit Alarms (Faults)	X Hard Copy		X
Audible Alarms	X Hard Copy		
Sub System Configuration	X Hard Copy		
Storage Data	X		
Instruction Address	X		
Set I.C.	X		
Store	X		
Display	X		
Start	X		
Stop	X		
Control CE	X		
Address Compare	X		
Rate	X		
IPL Controls	X		
Interrupt	X		
IBM 2821 Control Unit		X	
Printer - Card Read/Punch		X	
Sense Switches		X	

* Always operable from the Configuration Console

INPUT/OUTPUT EQUIPMENT, OPERATION

IBM 2540 CARD READ PUNCH

The IBM 2540 Card Read Punch (Figure 12) provides punched card input and output capabilities for the IBM 9020 System. The 2540 can read 1000 cards per minute and punch 300 cards per minute. The read and punch units operate independently and have separate controls, but share a common stacker unit.

The read unit is equipped with a file feed mechanism with a capacity of 3150 cards. Cards may be put into either the file feed or the reader hopper with the card weight placed on the top of the cards. If cards are to be placed in the reader hopper, the jogger gate must be opened (lowered). During automatic operation, the jogger gate must be closed. The cards are loaded and fed through the read unit 9-edge first, face down, and pass through three stations before entering the stacker unit (Figure 13). After the initial loading of cards, the read feed cycle is under program control.

The punch unit is equipped with a punch hopper with a capacity of 1200 cards. The cards are loaded and fed through the punch unit 12-edge first, face down, and pass through three stations before entering the stacker unit. After the initial loading of cards, the punch cycles are under program control.

The stacker unit is equipped with five stackers, each with a capacity of 1350 cards. Cards can be removed from the stackers without stopping card feeding. Cards from each feed can be program directed to three of the five stackers. Cards can be directed to stackers R1, R2, or RP3 from the read feed and to stackers P1, P2, or RP3 from the punch feed. The RP3 stacker can receive cards from either card feed.

CONTROLS AND INDICATORS

The switches and lights used in controlling the 2540 are shown in Figure 13.

Machine Indicators

These indicators display certain machine conditions such as card jams, full stackers, and blown fuses.

Power Light - This light indicates that power is being supplied to the 2540.

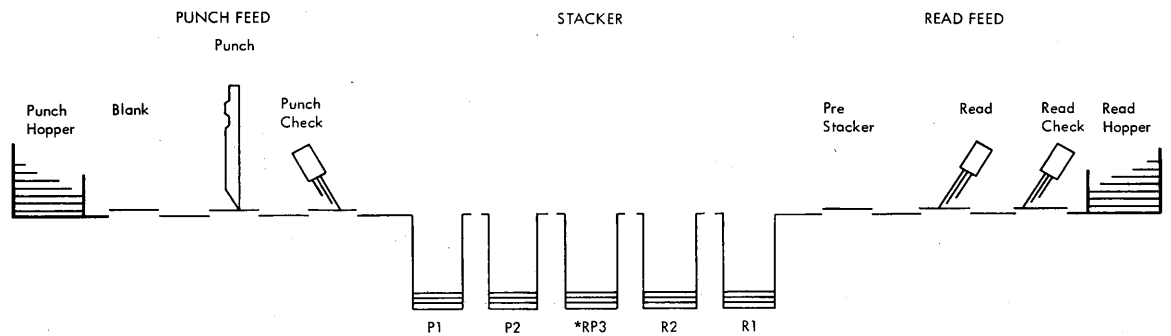
Fuse Light - This light indicates that a signal fuse is blown in the 2540. Notify the customer engineer if this light is on.

Stacker Light - This light indicates that one or more of the stackers are full. Both read and punch operations are stopped.



Figure 12. IBM 2540 Card Read Punch

Transport Light - This light indicates that a card jam has occurred in the stacker transport area. Card feeding is stopped in the read and punch units until the jam is cleared.



*RP3 is designated R3 during a read operation and P3 during a punch operation

Figure 13. IBM 2540 Card Flow Path

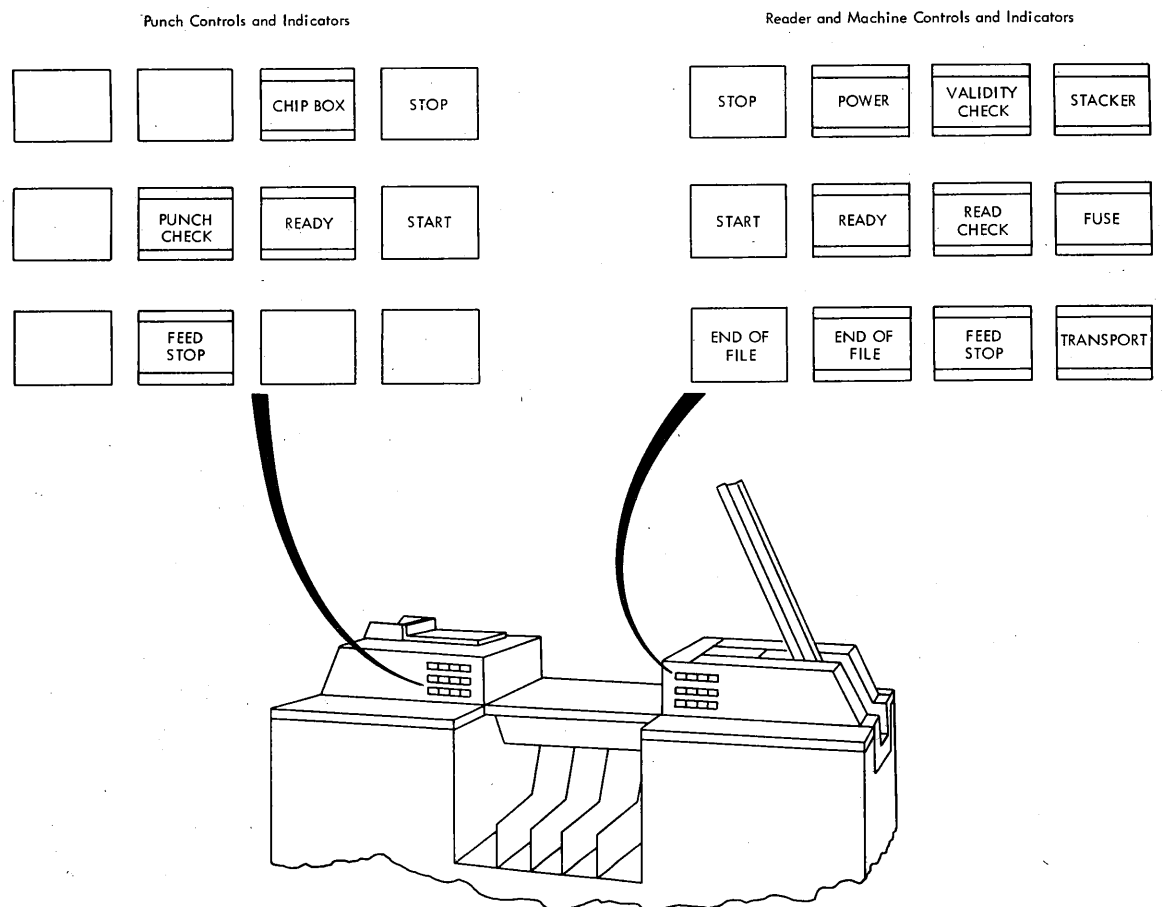


Figure 14. IBM Card Read Punch Controls and Indicators

Reader Keys and Lights

These keys and lights are used for controlling and monitoring the 2540 read unit operations.

Start Key - Pressing this key feeds three cards into the read feed, transfers the contents of the first card to the Integrated Control Unit (ICU), and turns on the Reader Ready Light.

When the reader has been stopped, pressing the reader start key turns on the reader ready light and allows the cards to continue feed-under program control.

Stop Key - Pressing this key stops the reader at the end of the feed cycle in progress, turns off the Reader Ready light, and resets the end-of-file condition.

End-of-File Key - Pressing this key turns on the End-of-File light, establishes an end-of-file condition in the ICU and enables the last card in the reader hopper to be processed. The End-of-File condition is reset after the last card has been processed or when the reader stop key is depressed.

End-of-File Light - This light indicates that the End-of-File key has been depressed and the 2540 is in an End-of-File condition. The light is turned off when the last card is processed or when the reader stop key is depressed.

Ready Light - This light indicates that the reader is ready for program-controlled operation.

Read Check Light - This light indicates that a hole count or parity error has occurred in the ICU during a read operation.

Feed Stop Light - This light indicates that a hopper feed failure or card jam has occurred, causing the reader to stop. The stop condition can be reset by clearing the read feed and initiating a non-process runout.

Validity Check Light - This light indicates that an invalid character has been detected during a read operation.

Punch Keys and Lights - These keys and lights are used for controlling and monitoring the 2540 punch unit operations.

Start Key - Pressing this key feeds two cards into the punch feed, stops the first card at the prepunch station, and turns on the punch ready light.

When the punch has been stopped, pressing the punch start key turns on the punch ready light, and allows the cards to continue feeding under program control.

Stop Key - Pressing this key stops the punch at the end of the feed cycle in progress and turns off the punch ready light.

Ready Light - This light indicates that the punch is ready for program-controlled operation.

Punch Check Light - This light indicates that a hole count or parity error has occurred in the ICU during a punch operation.

Feed Stop Light - This light indicates that a hopper feed failure or card jam has occurred, causing the punch to stop. The stop condition can be reset by clearing the punch feed and initiating a nonprocess runout.

Chip Box Light - This light indicates that the chip box is full, improperly positioned, or not in the machine.

OPERATOR'S GUIDE

Nonprocess Runout (Reader)

1. Remove cards from reader hopper.
2. Press reader stop and verify that end-of-file light is off.
3. Press reader start key and hold for several seconds to clear the read feed.

Nonprocess Runout (Punch)

1. Remove cards from punch hopper.
2. Press punch start key and hold for several seconds to clear the punch feed.

Making the Reader Ready

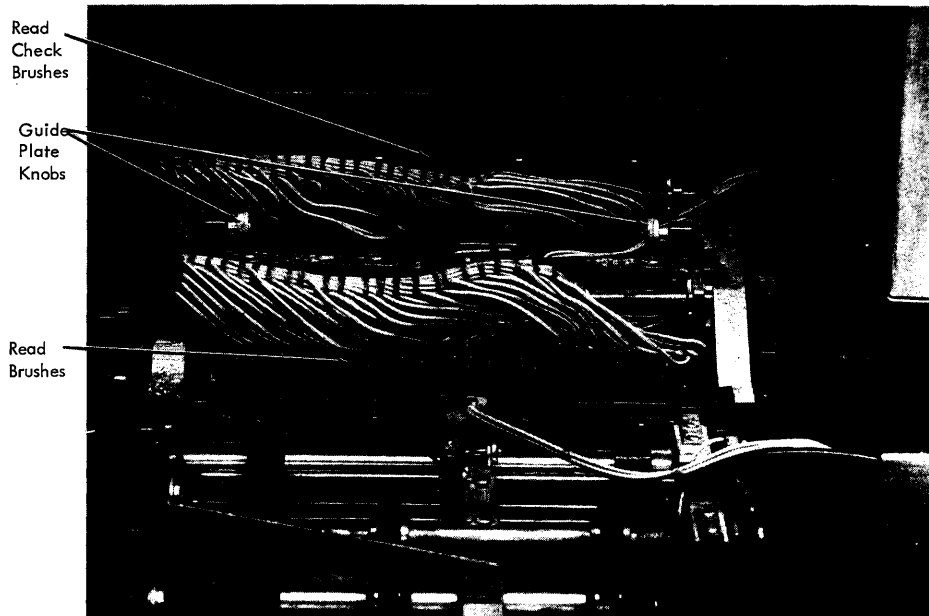
1. Initiate a nonprocess runout to clear the read feed.
2. Put cards into the file feed, 9-edge first, face down and place the card weight on top of the last card. Decks less than 1 inch thick should be loaded directly into the hopper.
3. Press reader start key.
4. Press end-of-file key.
5. Verify that reader ready light and end-of-file light are both on.

Making the Punch Ready

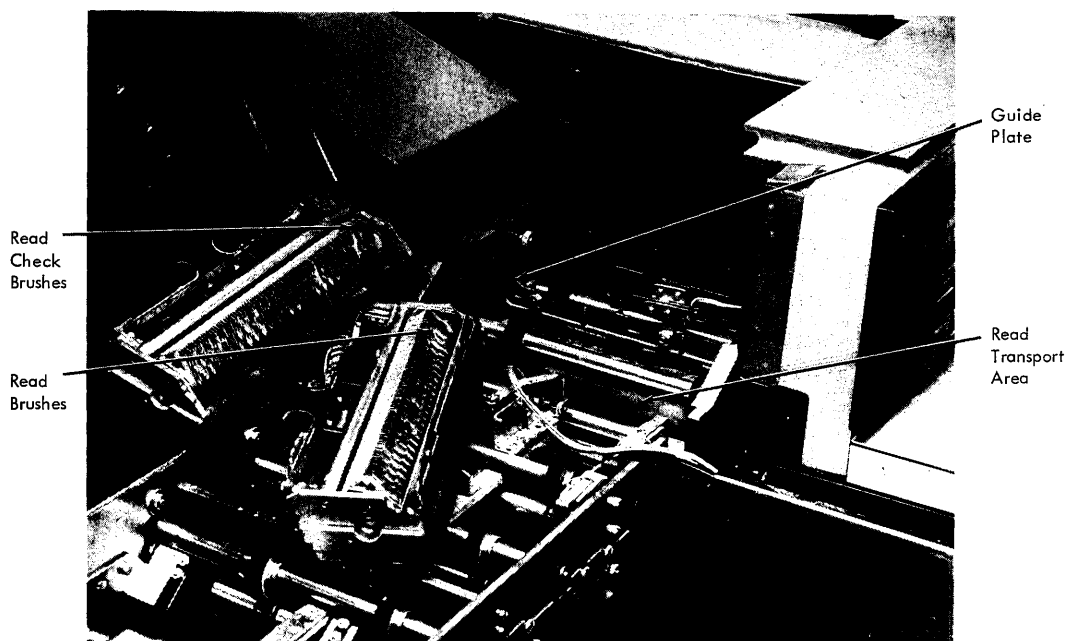
1. Initiate a nonprocess runout to clear the punch feed.
2. Place cards in punch hopper, 12-edge first, face down.
3. Press punch start key.
4. Verify that punch ready light is on.

Removing a Card Jam in the Read Feed

1. Remove the cards from the read hopper.
2. Lift the top cover to make the two sets of reading brushes accessible (Figure 15).
3. Open the right front door.
4. Remove both sets of brushes and lay them carefully on their sides. Never pull a card from the throat of the machine before removing the brushes (to avoid bending the brushes).



A. Read Brushes in place



B. Read Brushes removed

Figure 15. Read Feed

5. If complete access to read transport area is required to free the jammed cards, remove the guide plate between the sets of brushes, pull out the knobs and raise the guide plate from the machine.
6. Trip the clutch switch and turn the timing wheel clockwise to remove jammed cards (Figure 16).
7. Replace the brushes and guide plate carefully. As you re-set the brushes, turn the timing wheel clockwise.
8. Check that the brushes are latched firmly in place.
9. Check that all card fragments are removed by placing a blank card in the hopper, tripping the clutch, and turning the timing wheel until the blank card feeds through the read feed.
10. The cards that were under the brushes must be re-fed.
11. Before resuming operation, check the 9-edge of the first several cards removed from the read hopper, and duplicate any damaged cards.

Removing a Card Jam in the Punch Feed

1. Remove the cards from the punch hopper.
2. Lift the top cover to make the punch check brushes accessible (Figure 17).
3. Push the hopper latch (located on the back of the hopper) toward the rear of the 2540 and tip the hopper away from the machine.
4. Remove the brush assembly and lay it carefully on its side.
5. Remove the chip funnel (Figure 18).
6. Turn the "T" handle counterclockwise and pull down on the punch die.
7. Press the clutch release lever and turn the hand wheel until the clutch trips. Continue turning the hand wheel until the machine index is setting between 335° and 350° . (This zone is outlined in red on the index indicator.)
8. Remove the jammed cards and card fragments.
9. Replace the punch die by pushing it up into the punch unit and turning the "T" handle clockwise. If the die is improperly seated, it will fall with a slight downward tug on the "T" handle.
10. Replace the brush assembly, checking that it is firmly seated.
11. Close the hopper and the hopper latch.
12. Check that all card fragments are removed by placing a blank card in the hopper and turning the hand wheel until the blank card feeds through the punch feed.
13. Replace the chip funnel and close the machine covers.

Operating Pointers

1. The juggler gate on the read hopper must always be closed (raised) to feed cards. When it is open, the reader start key is inoperative, and a program instruction to read a card will stop system operation.
2. If the cards do not feed when the reader start key is pressed, and the juggler gate is closed, cards may have been

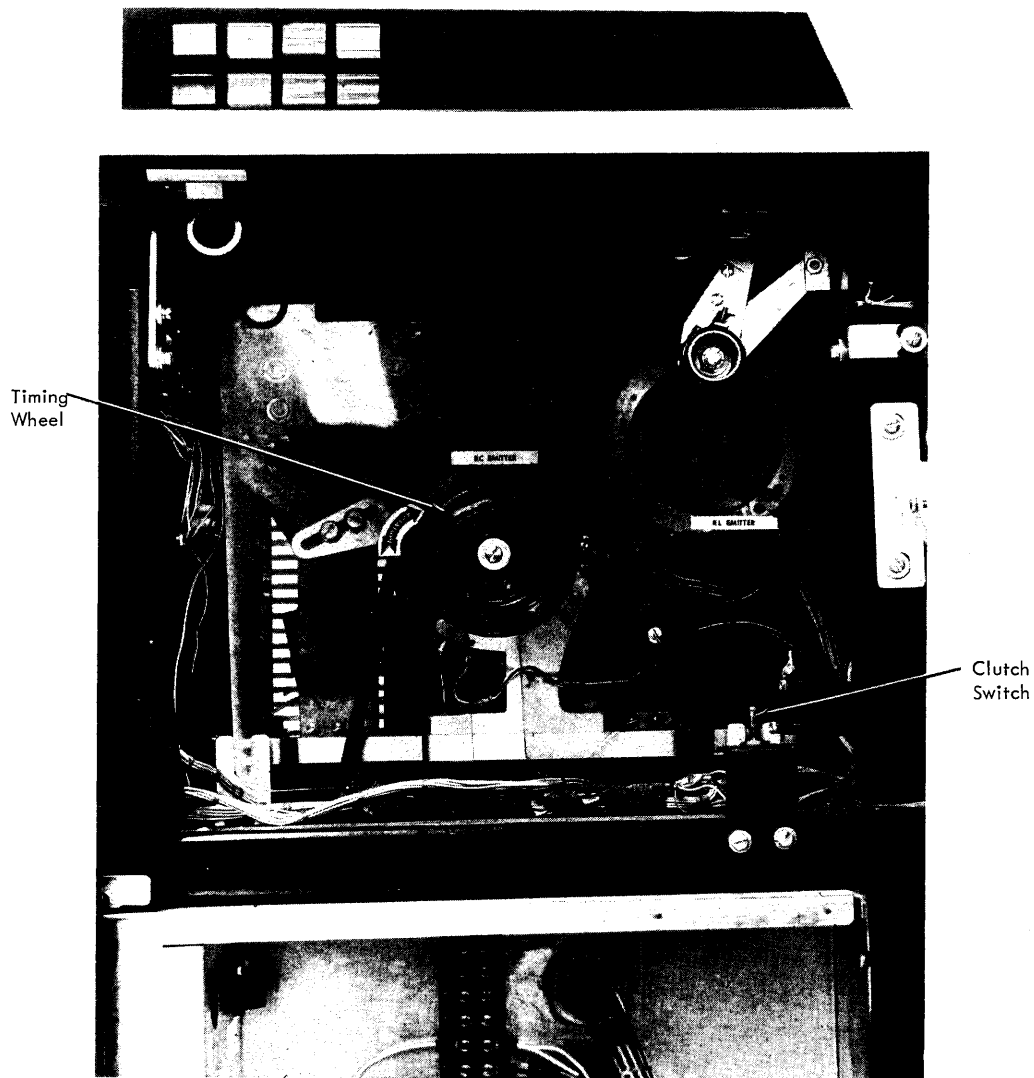


Figure 16. Read Clutch Switch and Timing Wheel

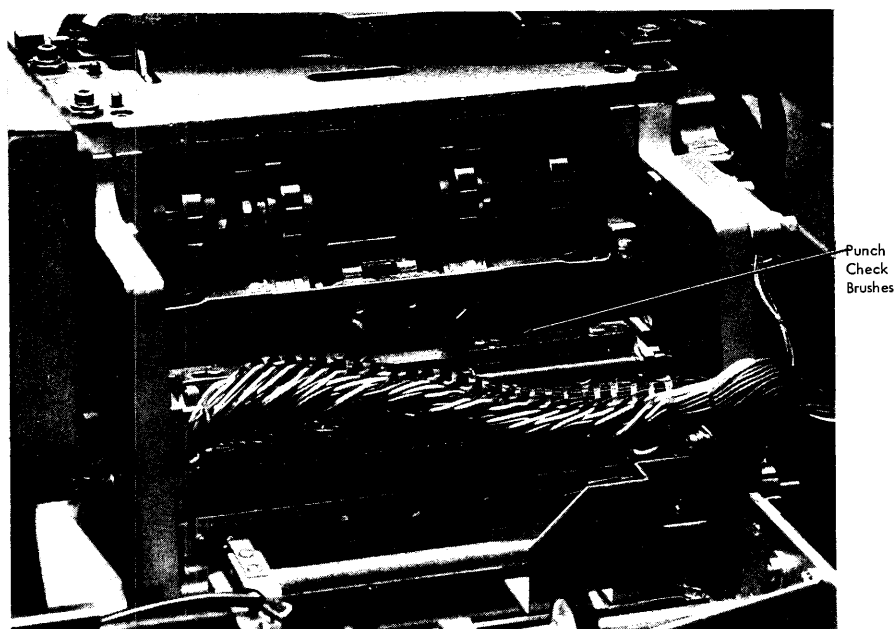


Figure 17. Punch Feed

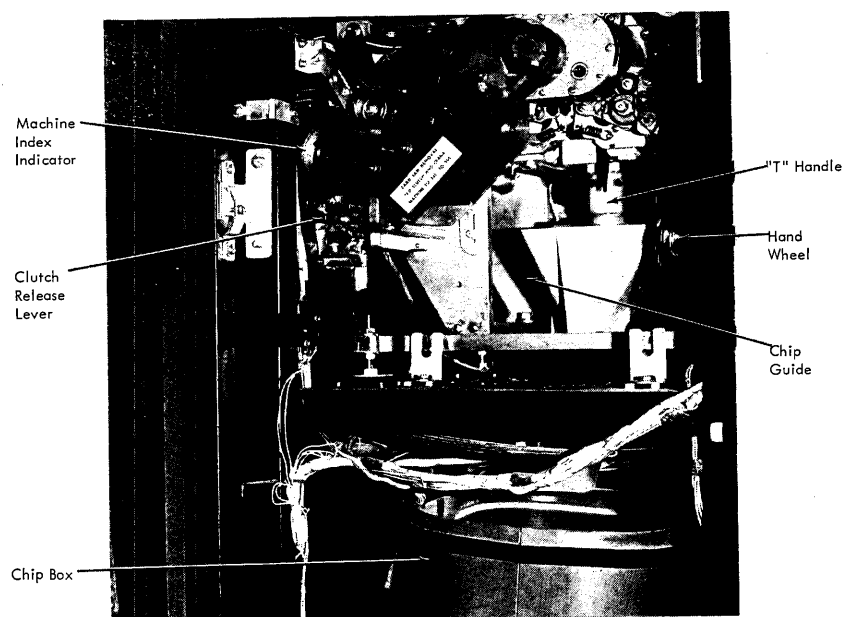


Figure 18. Punch "T" Handle and Machine Index

left in the read feed from the previous operation. Remove the program cards from the hopper (or file feed) and run the cards out of the feed.

3. If a card jam occurs (transport light on), lift the top cover to determine which feed unit is jammed, then perform the appropriate card jam removal procedure.
4. If an abnormal number of read check or punch check signals occur after a card jam has been removed, determine that the brush assemblies are properly seated.
5. When a brush assembly has been removed, take out all cards from that station before replacing the assembly. If a card is present when the assembly is replaced, the brushes will be damaged.
6. Whenever possible, avoid using adhesive patches on cards. They cause abnormal wear of the brushes and punches, and may cause an excessive number of card jams. If it is necessary to patch a card, apply the patches to the back of the card so that the punches and brushes do not touch the sticky side. Do not apply patching material to an entire field; patch only the individual holes that require patching.
7. Handle cards carefully. Damaged or badly warped cards may cause card jams; therefore, should be replaced. Thoroughly fan and joggle new cards before placing them in the punch hopper.

IBM 1403 PRINTER, MODEL 2

The IBM 1403 Printer Model 2 (Figure 19) serves as an output device for the IBM 9020 System. The 1403 has a maximum printing speed of 600 lines-per-minute, and a printing capacity of 132 positions. Each position can print 48 characters: 26 alphabetic, 10 numeric, and 12 special.

The characters are assembled on a chain (Figure 20) that travels in a horizontal plane. Each character is printed when it is positioned opposite a magnet-driven hammer that presses the paper form against the chain. As each character is printed, it is checked against the corresponding position in a print synchronizer to insure that the printed output is accurate. In addition, three other checks are made to verify that a character is printed in the correct position, that only valid characters are printed, and that overprinting does not occur.

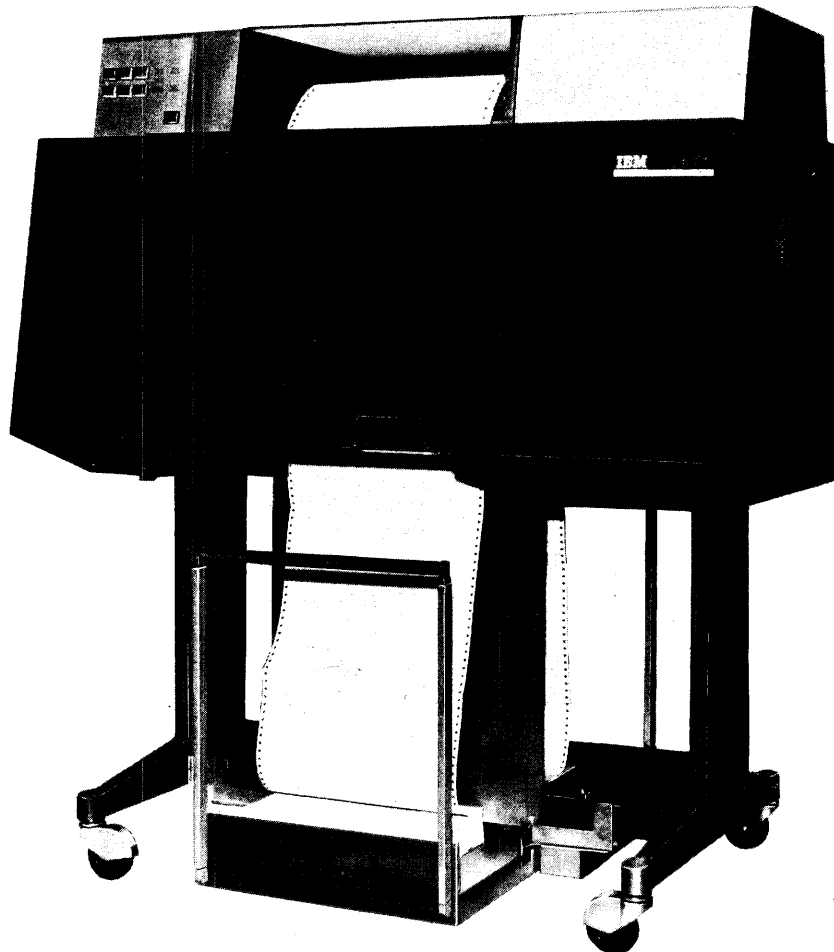


Figure 19. IBM 1403 Printer Model 2

With universal character set special feature, any set of graphics (240 maximum) may be used with the 1403 Model 2. The code corresponding to each graphic is entered into a 240-character read/write storage unit in the IBM 2821 Control Unit under control of a utility program. Though any graphic desired may be printed, the coding is restricted to the Extended BCD Interchange Code.

On the 1403 Model 2, the type slugs selected or designed by the user are installed in an interchangeable chain cartridge. By interchanging various cartridges, the operator can change the type font, style, or special-character arrangement. This change can be made quickly and easily; printer operation is not affected.

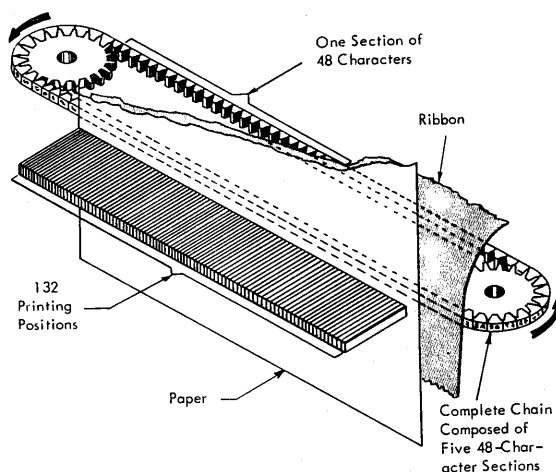


Figure 20. Printing Mechanism

CONTROLS AND INDICATORS

The keys, switches, and lights on the 1403 can be functionally separated into four areas: set up controls, machine controls, machine lights, and operation lights.

Set Up Controls

With these controls, the operator can control the paper feeding mechanism and printing mechanism for proper feeding.

Feed Clutch - The feed clutch (Figure 21) controls the carriage tape drive and form feeding mechanism. Forms can be fed automatically when it is set to drive. In drive position, either six or eight lines-per-inch is selected. With the clutch set to neutral, automatic form feeding cannot take place, but the tape-controlled carriage does function under program control or a carriage control key.

Paper Advance Knob - This knob positions the form vertically. It should be used only when the feed clutch is set to neutral.

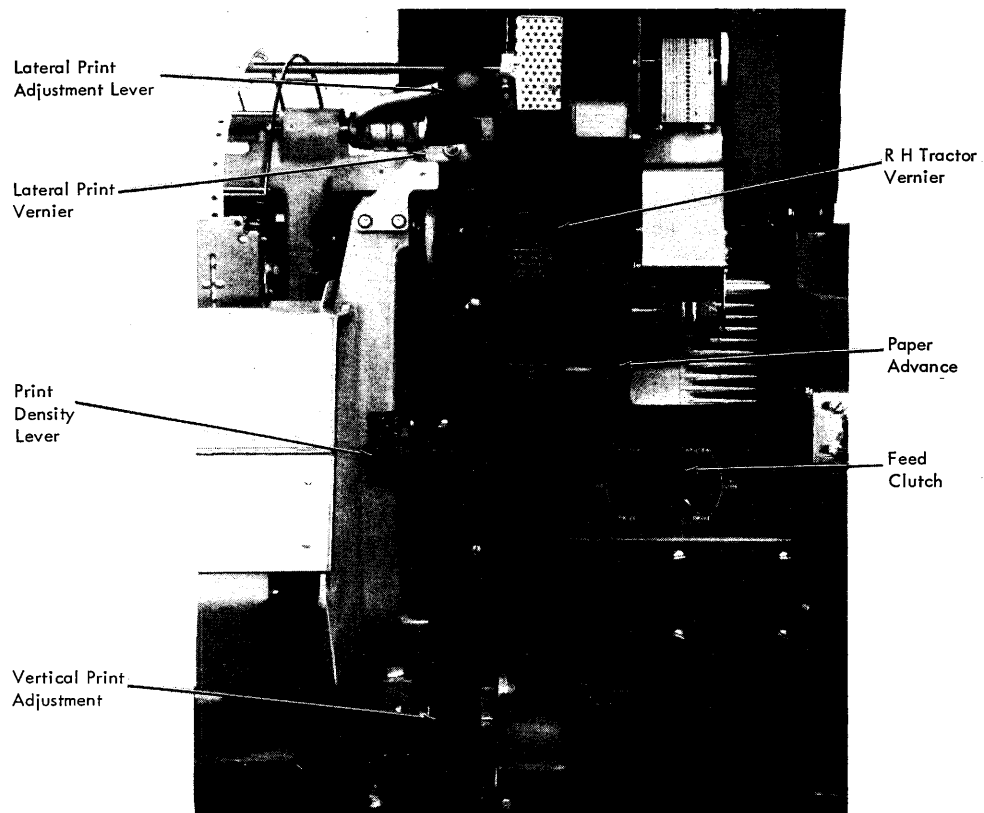


Figure 21. Printer Setup Controls

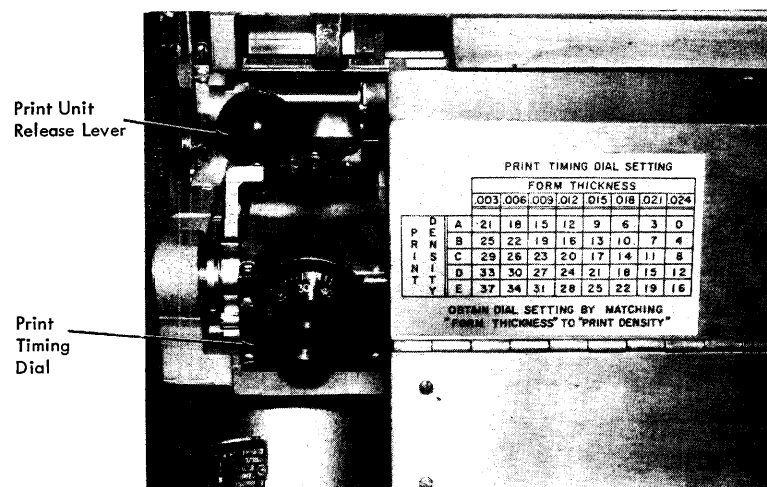


Figure 22. Print Timing Dial and Print Unit Release Lever

Vertical Print Adjustment Knob - This knob is used for fine vertical movement of the print unit within one line space, to obtain accurate registration of the print line. The carriage tape is not affected by this knob, which is operative with the feed clutch in either drive or neutral.

Lateral Print Adjustment Knob - With this knob, the print unit can be moved laterally to align the 1403 print positions with the corresponding positions on the form. Before the print unit can be moved, the knob must be rotated slightly away from the operator. The maximum distance that the unit can be moved is 2.4 inches.

Lateral Print Vernier Knob - This knob permits fine lateral positioning of the print unit for accurate registration of printing.

R H Tractor Vernier Knob - This knob is used to make fine adjustments in paper tension. The right-hand forms tractors are moved to the right or left, a maximum distance of one-half inch.

Print Density Lever - The 1403 print hammer unit adjusts automatically for different thicknesses of forms. However, the print density lever provides a vernier control for print impression. This lever moves the type chain closer to, or farther from, the hammer unit. When this lever is set at position A, printing is dark; at position E, printing is light. Between these two settings are three intermediate settings. Position C is considered the normal setting. The setting of this lever must be considered in conjunction with form thicknesses to determine the setting of the print timing dial.

Print Timing Dial - This dial (Figure 22) should be set to obtain the best printing quality for each run. The setting varies with the thickness of forms being fed and with the setting of the print density lever. A print-timing dial chart (Figure 23) on the ribbon cover gives the setting for eight different thicknesses combined with five

PRINT TIMING DIAL SETTING									
		FORM THICKNESS							
		.003	.006	.009	.012	.015	.018	.021	.024
P R I N T D E N S I T Y	A	21	18	15	12	9	6	3	0
	B	25	22	19	16	13	10	7	4
	C	29	26	23	20	17	14	11	8
	D	33	30	27	24	21	18	15	12
	E	37	34	31	28	25	22	19	16

Obtain Dial Setting By Matching
"Form Thickness" to "Print Density"

Figure 23. Print Timing Dial Chart

different settings of the print density lever. For example, if four part forms with interleaved carbons have a thickness of 0.015 inch and the print density lever is set at C, the chart specifies that the print timing should be set at 17.

Although the density settings vary by 4 in the chart, and the thicknesses by 0.003 inch, the operator can obtain a finer setting of the timing dial. To do this, start with the number read from the chart and turn the timing dial clockwise until the printing on the left side of the form becomes light. Then rotate the dial counter-clockwise until the printing on the right side of the form becomes light. The setting that should give the best printing is halfway between the two readings.

Print Unit Release Lever - Pulling this lever (Figure 22) toward you releases the print mechanism. Then swing open the mechanism to gain access to the forms transport area. When closing the print unit, push this lever firmly, as far as it will go, to latch the unit in place.

Forms Tractors - Marginally punched continuous forms are fed by two pairs (upper and lower) of forms tractors (Figure 24). The tractors can be positioned laterally to accept forms of various overall widths between 3-1/2 and 18-3/4 inches.

The adjustments for the upper and lower tractors are identical, and the tractors should be positioned alike to maintain correct alignment of forms. Each pair of tractors is locked in place by a spring-loaded latch in any one of nine notches located 1 inch apart in the tractor slide bar. The fourth notch from the left is the best location for most applications.

The right-hand tractor is locked in place by a spring-loaded pin in any one of 27 holes located one-half inch apart in the tractor slide bar. After the right-hand tractors are locked in place, a fine adjustment (up to one-half inch) can be made by the right-hand tractor vernier.

Left-Hand Tractor Lock - This spring-loaded lever releases the left-hand tractor so that it can be moved and locked in any one of nine notches in the tractor slide bar.

Right-Hand Tractor Pin Latch - Pulling out this spring-loaded pin releases the right-hand tractor so that it can be moved along the tractor slide bar. It is snapped into any one of 27 holes to lock the tractor in place.

Ribbon Shield and Print-Line Indicator - This shield prevents the ribbon from smudging the forms as they are printed. It pivots with the print unit when it is opened. With the print unit open, swing this shield back against the forms and use it as a guide for the proper positioning of forms. A lever on top, at the left end of the shield, releases the shield from the print unit.

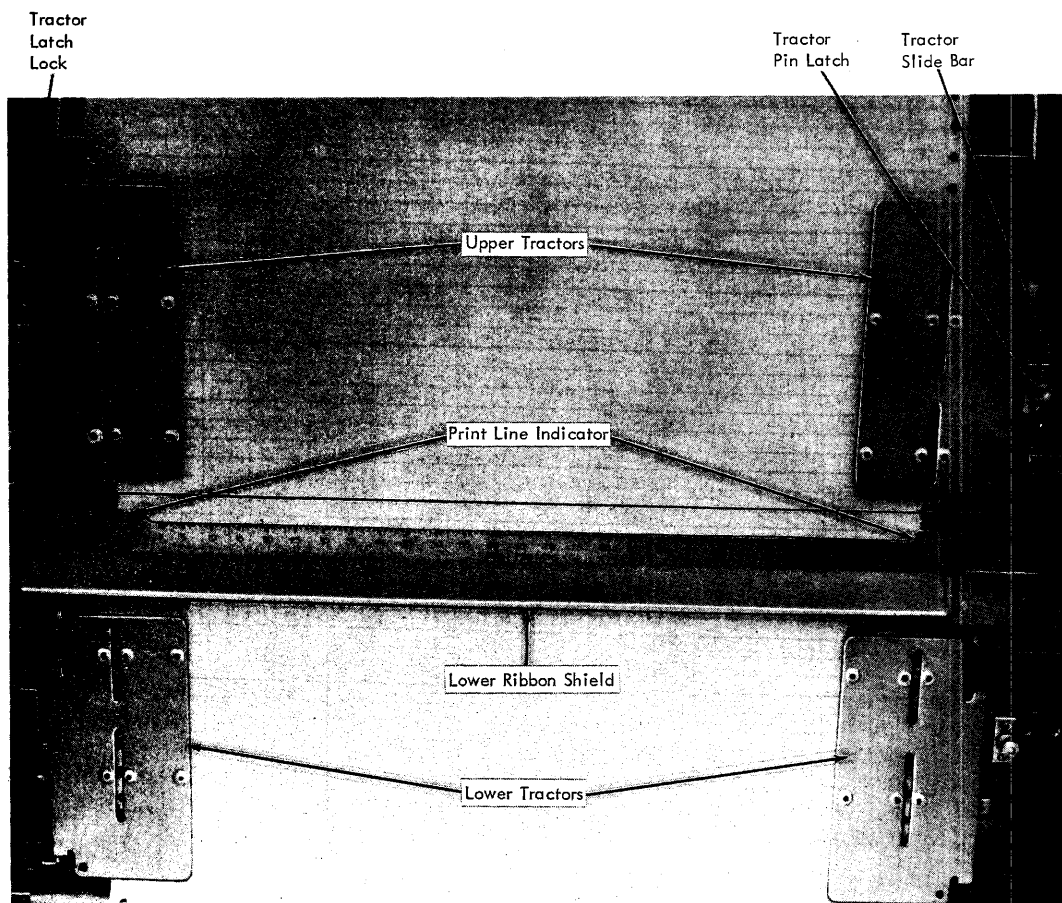


Figure 24. Forms Feeding

The front of the shield shows the location of the 132 print positions. The ends of the shield indicate where the lower edge of characters will print.

The ribbon shield wire holds forms away from the ribbon to prevent smudging the forms when the machine is idling. When continuous card forms are fed, however, the ribbon shield wire should be removed to prevent bursting the forms. Refer to the Operator's Guide section for removal instruction.

Paper Guide - This device guides forms that have been printed to an output-paper cart at the rear of the machine (Figure 25). The guide can be raised or lowered to accommodate forms of various sizes by sliding the paper-guide control lever up or down in its track. A scale (0-6) is printed along this track so that the setup position for a particular form can be recorded in the operator's procedures. For the best stacking operation, this guide should be set as low as possi-

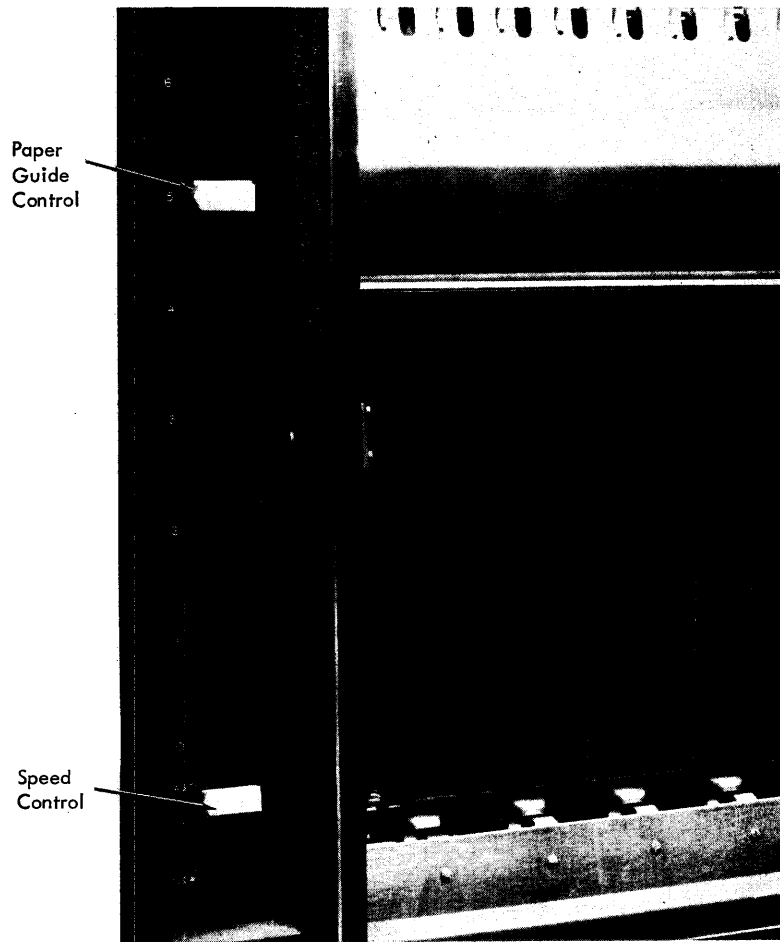


Figure 25. Paper Stacking Controls

ble , allowing enough space for the forms to fanfold into a stack. Thus, the original setting for a run depends on the depth of the forms. As the stack of forms increases, the guide must be moved up. The lower control acts as a speed control that keeps the proper tension on the paper feeding into the stacker.

Machine Controls

With machine controls (Figure 26), the operator can control machine operation.

Start - Pressing this green key starts machine operation. A duplicate start key is located at the rear of the printer for operator convenience.

Stop - Pressing this red key stops machine operation at the completion of the instruction in process. A duplicate stop key is located at the rear of the machine for operator convenience.

Carriage Stop - Pressing this red key stops carriage movement immediately and turns on the forms check light.

Single Cycle - Each time this key is pressed during a print operation, the printer operates for one print cycle.

If the End-Of-Forms light is on, this key can be pressed repeatedly to complete the printing on the present form. When channel 1 of the carriage control tape is read, indicating that the next form (if any) has been fed, this key becomes inoperative.

Check Reset - This key resets a printer error indication. To resume operation, press the start key.

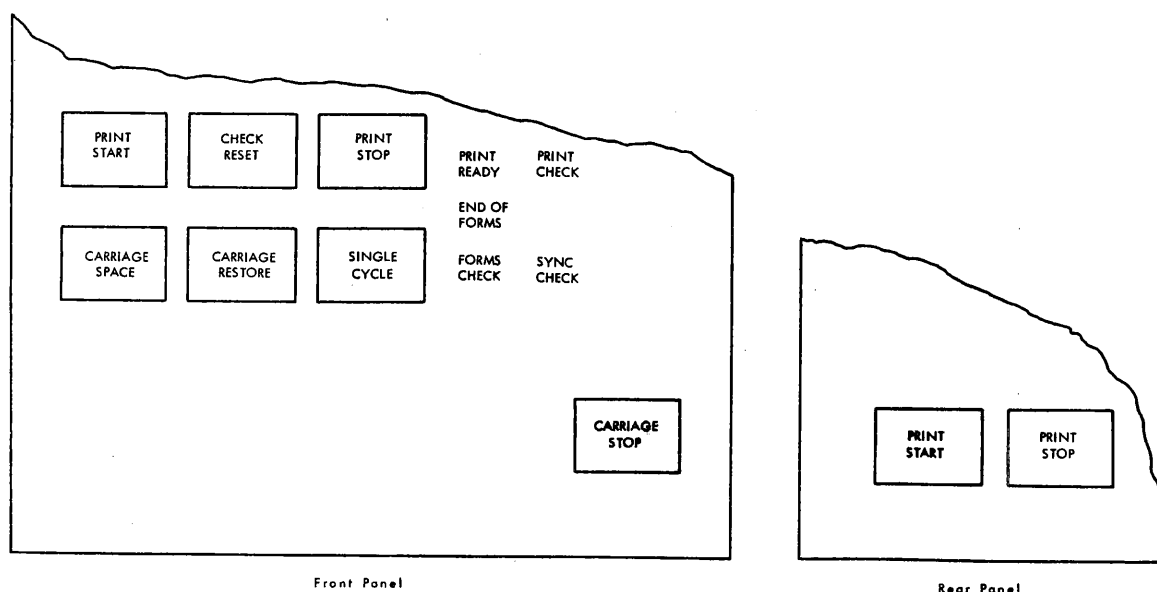


Figure 26. Printer Keys and Lights

Carriage Space - Each time this key is pressed, the forms and carriage tape advance one space.

Carriage Restore - This key positions the carriage at channel 1 (home position). If the carriage feed clutch is disengaged, the forms do not move. If it is engaged, the forms move in synchronization with the tape-controlled carriage. This key is inoperative if either the print unit or the carriage-tape brush holder is open.

Machine Control Lights

These lights (Figure 26) indicate various check conditions and printer status (ready or not ready.)

Print Ready - This light turns on when the printer is in condition to print. If the print unit is opened, this light turns off. The light turns on again when the print unit is closed and the print chain reaches printing speed.

Print Check - This light turns on if:

1. A print hammer failed to operate, or operated when it should not have.
2. Storage positions containing printable data did not have an opportunity to print.

This light can be turned off by pressing the check reset key.

End of Forms - This light turns on and the machine stops when the last form in a stack is fed through the machine, or when a break in forms occurs at either the upper or lower left-hand forms tractor. If an end-of-forms condition occurs during a skip, the skip in process is completed, but printing does not occur.

The light turns off when more forms are inserted in the machine, or when the break in the forms is corrected.

Forms Check - This light indicates paper-feed trouble. Any of the following conditions may turn on the forms check light:

1. The forms are off the forms tractors.
2. The carriage stop key was pressed.
3. Printer adjustments that required opening the forms tractors were made.

The light can be turned off by pressing the check reset key.

Sync Check - This light turns on if the print chain was out of synchronization with the integrated control unit. It can be turned off by pressing the check reset key. The timing is corrected automatically.

Machine Operation Lights

These lights (Figure 27) indicate the status of certain printer interlocks and operations. The lights are mounted on an indicator panel located near the feed clutch.

Gate Inlk - This light is on when the print unit is not locked in position.

Brush Inlk - This light is on if the carriage tape brushes are not latched in position for operation.

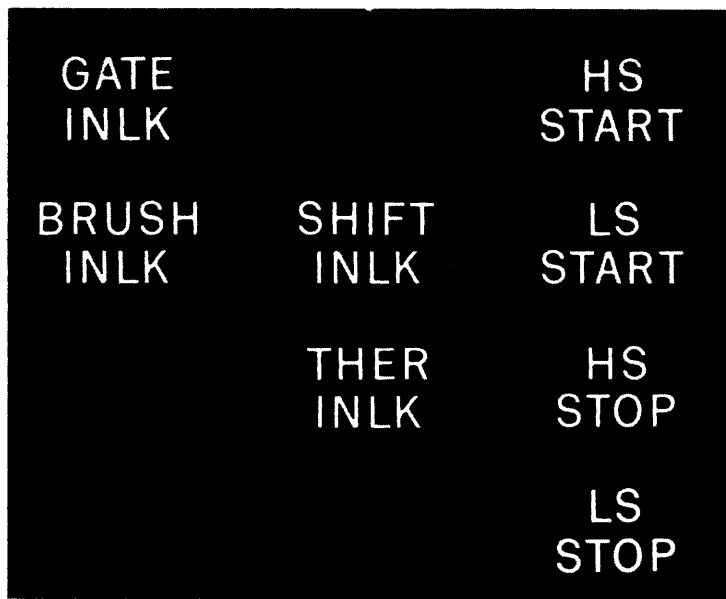


Figure 27. Indicator Panel Lights

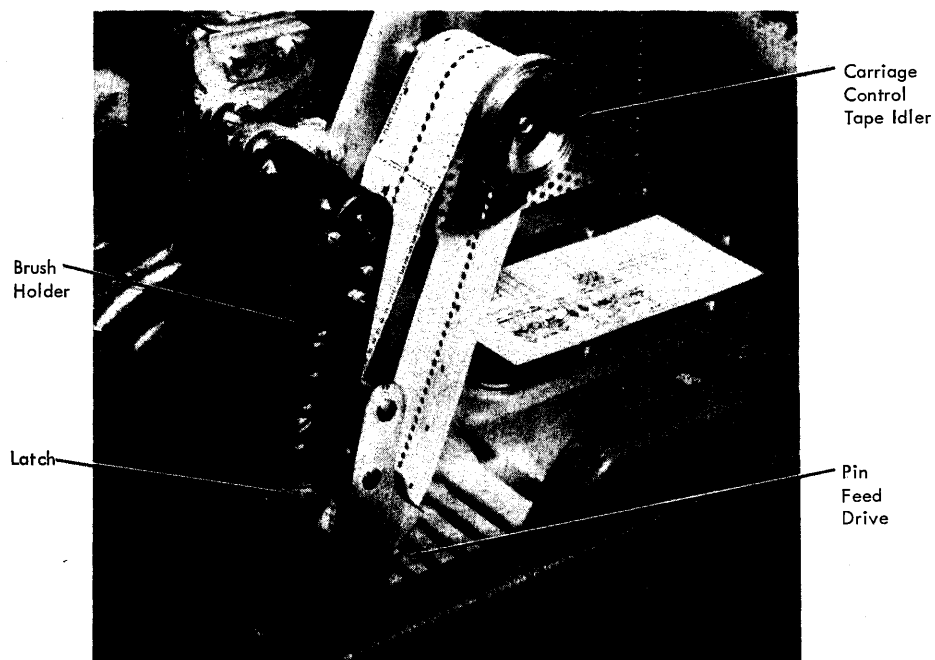


Figure 28. Tape Controlled Carriage

Shift Inlk - This light is on if the feed clutch is not set at either drive or neutral.

Ther Inlk - This light is on if a high-speed skip has been initiated.

LS Start - This light is on if either a low-speed skip or line spacing has been initiated.

HS Stop - This light indicates that high-speed skipping is to be stopped.

LS Stop - This light indicates that a low speed skip-stop has been initiated. It is also on whenever the carriage is not in motion.

OPERATOR'S GUIDE

Inserting A Carriage Tape

1. Raise the front cover of the printer to gain access to the tape-controlled carriage.
2. Turn the feed clutch to neutral (see Figure 21).
3. Raise the carriage brush holder (Figure 28) by pushing the latch on the side of the holder toward the front.
4. Holding the tape loop so that the printed captions can be read, place the tape over the pin-feed drive so that the pins engage the center drive holes. The line numbers on the tape must face the right end of the 1403.
5. Loop the tape around the adjustable carriage-control-tape idler.
6. Remove the excess slack from the tape by loosening the locking knob on the idler and sliding the idler in its track. Tighten the knob when the desired tension is reached. The tape should be just tight enough so that it gives slightly when the top and bottom portions of the loop are pressed together. If it fits too tightly, the pin-feed holes may be damaged.
7. Press the brush holder down until it latches.
8. Press the carriage restore key to bring the tape to its home position (channel 1).
9. Set the feed clutch to the desired drive position (either six or eight lines to the inch.)
10. Close the print cover. The carriage is now ready to operate.

Inserting Forms

1. Raise the front cover of the printer to gain access to the print unit and forms area.
2. Turn the feed clutch to neutral (Figure 21).
3. Unlock and swing back the print unit by pulling the print-unit release lever (Figure 22) toward you.
4. Set both the left-hand forms tractors (Figure 24) slightly to the left of the first printing position. Pull the tractor lock up (or down) and slide the tractor until it latches

- in the appropriate notch.
5. Open the left-hand tractor covers, and place the forms over the pins. Close the tractor covers.
6. Open both right-hand tractor covers.
7. Move the right-hand tractors to the desired location to line up the right side of the forms. Pull out the tractor pin latch, and slide the tractor until the pin snaps into the appropriate position.
8. Place the forms over the tractor feed pins and close the tractor covers.
9. Tighten the tension on the form, using the RH tractor vernier (Figure 21).
10. Check the position and line where printing will occur by swinging the ribbon shield against the form. If the horizontal alignment is not correct, adjust it by using the lateral-print vernier knob for slight adjustments. Make any vertical adjustments by using the paper advance knob, and/or the vertical print adjustment knob for fine adjustments.
11. Close and lock the print unit in place. Be sure to push the print-unit release lever as far as it will go.
12. Restore the carriage tape to the first printing position by pressing the carriage restore key (Figure 26).
13. Set the feed clutch at drive position (Figure 21). Set it for either six or eight lines-per-inch, depending on the form to be printed.
14. Close the front cover of the printer.
15. Position the paper supply on the input-paper cart so that the forms feed straight up into the machine.

Inserting Additional Forms on and End-of-Forms Condition

The last form fed through the machine may be detected during a skip from one form to another, or while skipping or spacing within a form. If it is detected during a form-to-form skip, the skip is completed, but printing does not occur and the following steps should be taken:

1. Insert the new forms on the forms tractors (see "Inserting Forms"), aligning the top of the new form with the bottom of the last form. This positions the new form for printing on the skipped-to line.

If the form-to-form skip moved the last form beyond the upper forms tractors, determine (from your procedure write-up) the line on the form to which the skip was directed. Insert the new forms, positioning the skipped-to line for printing.

Inserting the new forms turns off the end of forms light, making the single cycle key (Figure 26) operative.

2. Make any slight adjustments that may be necessary for accurate registration by using the vertical print adjustment and/or the lateral print vernier knobs (Figure 21).

NOTE: If the form spans both the upper and lower forms tractors when it is inserted (step 1), steps 3 and 4 are omitted.

3. Press the single cycle key (Figure 26). Printing occurs on the skipped-to line. Press this key repeatedly to print on the first form until it reaches the upper forms tractors.
4. Insert the new form on the upper forms tractor.
5. Press a start key to resume operation.

If the end-of-forms condition is detected while skipping or spacing within a form:

1. Print the rest of the form, using the single cycle key.
2. When the skip (or space) to the next form occurs, follow the same procedure as described in the preceding five steps.

Changing Ribbons

Ribbons are available in widths of 11 and 14 inches. The ribbon-width lever (Figure 29) adjusts the ribbon-feed mechanism to accommodate either width.

Removing a Ribbon

To remove a ribbon:

1. Lift up the front cover of the printer.
2. Swing the print unit out by pulling the print-unit release lever toward you (Figure 22).
3. Open the ribbon cover (Figure 30).
4. Unlatch the ribbon shield, and swing it against the form.
5. Push the top ribbon roll toward the hinged side of the print unit (drive end), lift out the other end of the ribbon roll, and remove the roll from the drive mechanism.
6. Slip the ribbon out from under the ribbon correction roll, which may be lifted to free the ribbon.
7. Remove the bottom roll by following the same procedure as described in step 5 for the top roll.

Installing a Ribbon

A new ribbon is fastened on two spools with most of the ribbon on one of the spools. To install the ribbon:

1. Install the full ribbon roll in the lower position by following, in reverse order, the procedure described in step 5 under "Removing a Ribbon". To lock the roll firmly in place in the drive end, position the roll so that the two notches in the end of the spool coincide with two pins in the socket.
2. Wind ribbon onto the empty spool until the ribbon-reversing bar is on the spool. The ribbon-reversing bar is a metal strip that is permanently fastened to the ribbon and that reverses the direction of the ribbon when all the usable

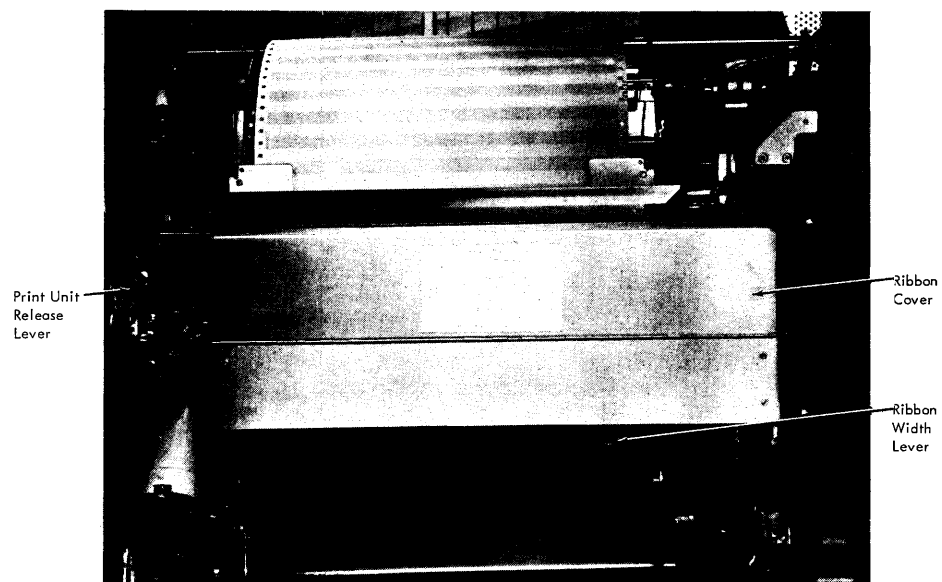


Figure 29. Ribbon Width Lever

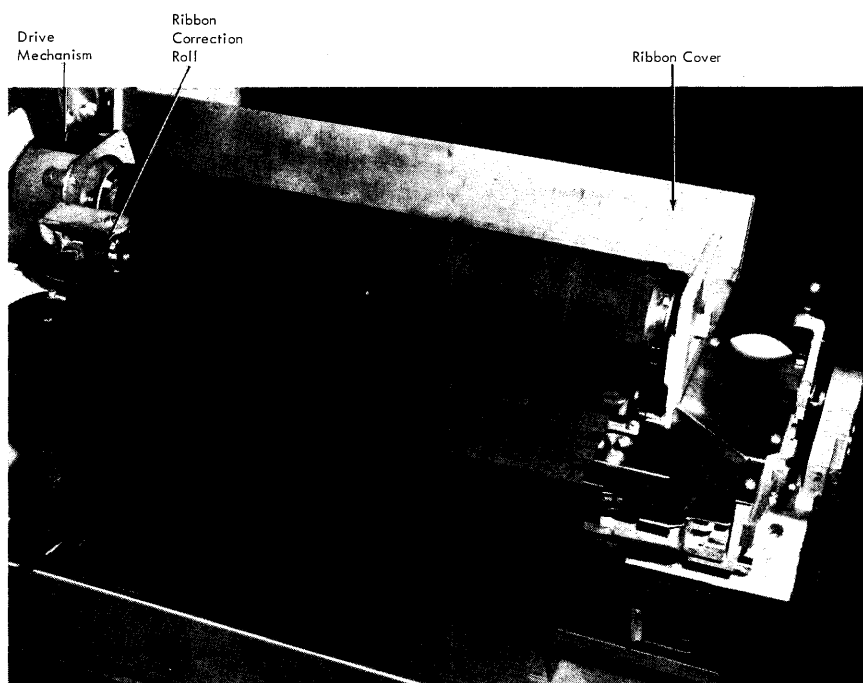


Figure 30. Ribbon Mechanism

ribbon is on one spool. Therefore the ribbon-reversing bar must always be positioned between the ribbon-reversing lever and the spool. (Figure 31).

3. Route the ribbon between the print chain and the ribbon shield, and slide it under the ribbon-correction roll.
4. Install the empty spool in the upper position by following in reverse order, the procedure described in step 5 under "Removing a Ribbon."
5. Take up any slack in the ribbon by manually turning the upper ribbon roll.

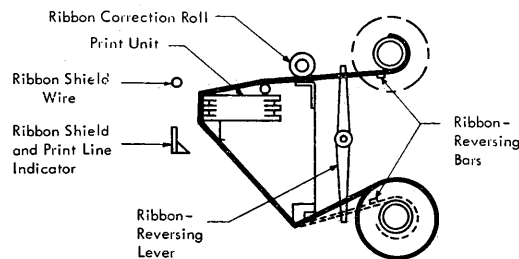


Figure 31. Ribbon Mechanism Schematic

Cleaning the Print Chain

Call the customer engineer when the 1403 print chain requires cleaning.

Interchangeable Cartridge Changing

1. Raise the printer cover.
2. Pull back and unlock the print-unit release lever. Swing the print unit out.
3. Open the top ribbon cover.
4. Unlatch the print-line indicator and swing it against the form.
5. Remove the top ribbon spool as described under "Changing Ribbons," and place it on the tray at the bottom of the print unit.
6. Pivot the two handles on top of the cartridge to their vertical position. The cartridge is unlocked and may be lifted free of the print unit by the handles.
7. Using the special tool attached to the printer, turn the notched driver on the right side of the print unit until a screw is visible in the nearby open hole in the cover plate. If any further adjustment is required to align the notch in

the driver with the notch in the casting, complete this alignment. This final adjustment is minor if the screw is properly positioned.

8. With the same tool, turn the driver gear in the new cartridge until the appropriate character on the specially marked slug is in line with the arrow engraved on the cartridge base. On all standard cartridges, the proper character is the digit "1" on the marked type slug.
9. Place the cartridge on its locating pins in the print unit.
10. Lock the cartridge in place by pivoting the handles down to their horizontal (original) position.
11. Replace the ribbon spool.
12. Close and lock the print unit.
13. Lower the cover.

Ribbon Shield Wire Removal

1. Raise the front cover to gain access to the print unit and forms area.
2. Unlock and swing back the print unit by pulling the print-unit release lever toward you.
3. Pivot the ribbon shield towards the form area.
4. Release the spring-loaded tension lever on the right end of the ribbon shield.
5. Disconnect the ribbon shield wire from the stud on the tension lever.
6. Remove the ribbon shield wire from the grooves in the left and right hand castings.
7. Disconnect the ribbon shield wire from the stud on the left-hand shield casting.

Ribbon Shield Wire Installation

1. Perform steps 1-3 of "Ribbon Shield Wire Removal."
2. Connect the looped end of the ribbon shield wire to the stud on the left-hand ribbon shield casting.
3. Thread the ribbon shield wire through the grooves in the left and right-hand castings.
4. Connect the ribbon shield wire to the stud on the tension lever.
5. Latch the spring-loaded tension lever in place.

Operating Pointers

1. If many errors are signaled by the forms check light, the input-paper cart may not be positioned correctly. Move the cart so that the forms feed straight up to the forms tractors. This is especially important for thick forms.
2. Be sure the paper cart is grounded against the machine to reduce the static electricity generated by paper as it feeds into the machine. If it is not properly grounded, the sync check light may turn on intermittently.

3. To start forms stacking properly, guide the leading edge of the first form into the stacking gate at the rear of the machine.
4. If all printing occurs on the same line, the feed clutch was left in neutral. Set it to drive.
5. Check that the feed clutch is set correctly for the forms to be printed at 6 or 8 lines-per-inch spacing. If less than the proper amount of printing appears on a form, the clutch is probably set at 6 lines-per-inch, but should be set at 8 lines-per-inch. Conversely, if more printing than expected appears on a form, the clutch is probably set at 8 lines-per-inch, but should be set at 6 lines-per-inch.
6. If the carriage does not restore to the home position when the carriage restore key is pressed, check that the carriage tape is properly positioned over the pin-feed drive and that the brush holder is latched in place.
7. If a forms runaway occurs, depress the carriage stop key. If this action does not stop the forms runaway, tear off the forms below the forms tractors and notify the customer engineer.
8. A forms runaway is generally caused when a skip is initiated and no skip-stop punch in the carriage tape is read. Check that the correct carriage is installed and that it is not torn.
 - A forms runaway can also be caused by:
 - a. Control tape reverse in the carriage (inserted with printing away from the operator.)
 - b. Two or more skip-stop punches in the same line of tape.
 - c. Program error.
9. If the single cycle key is pressed during system operation, the operation stops at the end of the next print cycle. Press the start key to resume operation.
10. If the print unit or carriage brush holder was opened and closed again during system operation, printing will not occur when the next print instruction is given. Press the start key to resume operation.
11. If the feed clutch is turned to neutral and back to drive during system operation, printing will not occur when the next print instruction is given. Press the start key to resume operation.
12. When inserting new forms on an End-of-Forms condition, do not restore the carriage if the skip-to-line is at any position other than the first printing line on the form. Restoring the carriage at this time could get the forms,

carriage tape, and program out of step.

13. If it is necessary to press the carriage stop key because of a forms runaway, check the carriage tape to see that the proper tape is correctly mounted and has not been damaged.

IBM 1052 MODEL 7 PRINTER-KEYBOARD

The IBM 1052 Model 7 Printer-KeyBoard (Figure 32) provides communication capabilities between the system operator and the IBM 9020 System. Functionally, the 1052 operation is separated into two major sections: keyboard and printer.

Keyboard Operation

The 1052 keyboard enables the operator to directly introduce input data into the system. The 55 keys on the keyboard enable 88 different printable characters and mechanical control signals such as space backspace, line feed, tabulate and carriage return to be entered into the system as input data. Other special keys allow for alternate coding, shift, and shift-lock. However, these operations are not entered into the system.

The keyboard is similar in appearance and operation to the standard IBM typewriter. Pressing any of the keys generates a corresponding code. The code is then relayed to the system as input data. To prevent simultaneous depression of two keys, all keys are mechanically interlocked except:

1. Alternate coding (altn coding).
2. Carrier return (return) and line feed keys (with each other only).
3. Z key and tabulate (tab) keys (with each other only).
4. Shift keys (locked together).

Printer Operation

The printer section of the 1052 accepts data transferred from the 9020 system. The printer is similar to the printing mechanism of the IBM Selectric typewriter. The paper remains stationary during printing and a single printing element, shaped like a ball, moves horizontally across the paper to accomplish the printing. The element contains all of the 88 characters capable of being printed by the 1052. An original and five carbon copies can be printed, depending on the carbon quality and thickness. The margins, tab stops, and ribbon shift (color) are manually set by the operator.

When the printing element carrier moves within 12 character positions of the right margin, a signal bell operates. A carrier return or tabulation suppresses printing. However, when operating on or off line, if the carrier reaches the right margin (end of line) without a carrier return signal, the carrier returns automatically and suppresses printing.

The presence of paper is necessary to satisfy interlock circuitry required to place the printer in a state of readiness. Lack of paper is indicated by a contact approximately 2 inches from the print line.

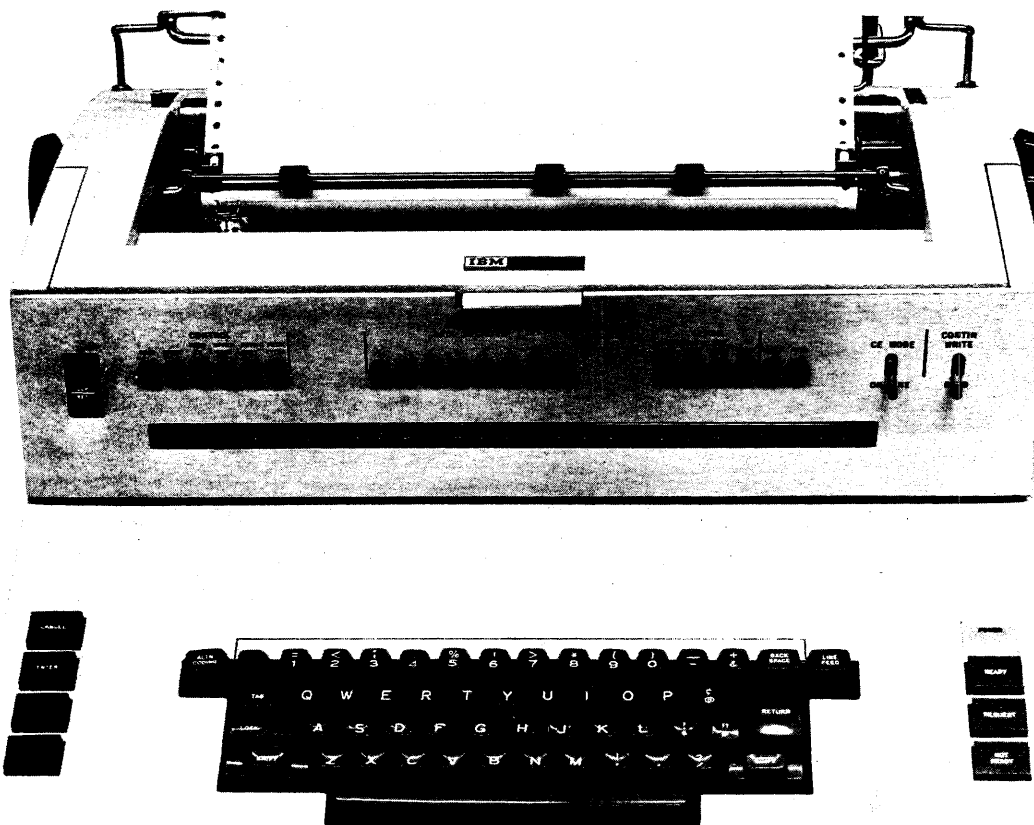


Figure 32. IBM 1052 Model 7 Printer-Keyboard

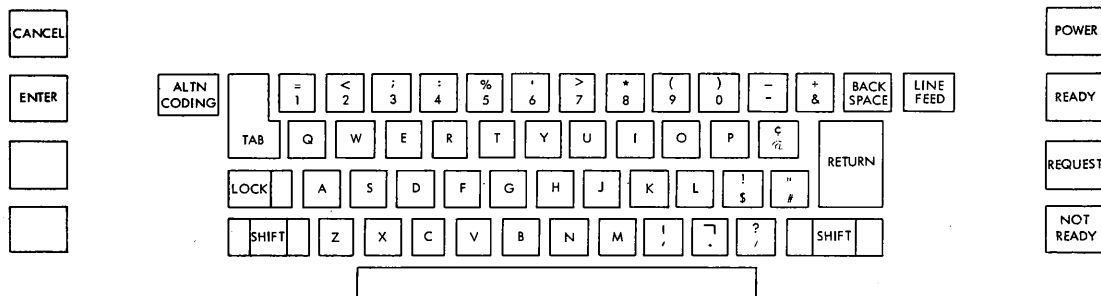


Figure 33. Machine and Keyboard Controls

Printing will not be interrupted by running out of paper. When paper is out, and the printer is addressed again, a negative response is transmitted to the computing element.

Control Unit

The 1052 control units (CU) supply overall control for the 1052 units. In the 9020D System the CU for the system console-connected 1052 is contained within the console; the CU for the peripheral adapter module (PAM)-connected 1052 is contained within the associated PAM. Both the 1052 units are program addressable. In the 9020E System, each CE has a 1052 CU built-in. However, the 1052 is remotely located.

CONTROLS AND INDICATORS

The 1052 controls and indicators can be functionally separated into three groups: machine controls and indicators, printer controls, and keyboard controls.

Machine Controls and Indicators

These controls and indicators (Figure 33) are used for controlling and monitoring 1052 operations.

Ready Key - Pressing this key causes the 1052 to become ready when there is paper in the unit and the CU is not busy. The 1052 must be in the ready condition to perform read and write operations.

Request Key - Pressing this key causes the 1052 to assume the attention status.

Not Ready Key - Pressing this key causes the 1052 to become not ready, thereby prohibiting read or write operations.

Control Lights - See Figure 34.

Read: This light indicates that a read command has been accepted and is in progress.

Write: This light indicates that a write command has been accepted and is in progress.

Inhib Cr: This light indicates that a write and inhibit carrier return command has been given.

Upper Case: This light indicates that the lower-case latch is off.

Prtr Busy: This light indicates that the printer is taking a cycle.

Prtr Cycle: This light is turned on at the beginning of a cycle and turned off towards the end of the cycle. If the light remains on, it indicates that the printer did not take action when a shift, space, tab, backspace, or print character was given.

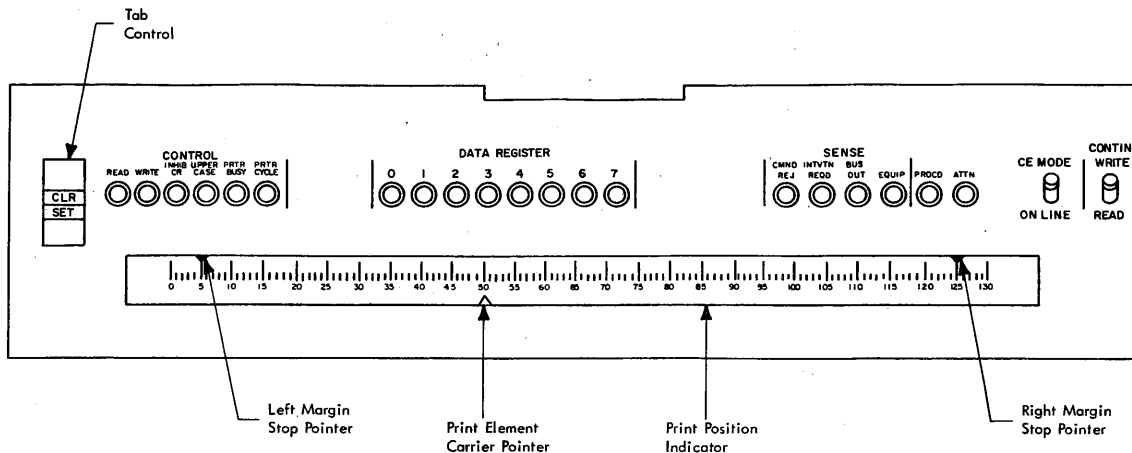


Figure 34. Indicator Panel

Data Register Lights - These lights indicate the contents of the data register. In a read operation, the data register retains the last character keyed until a new character is keyed. In a write operation, the data register retains each byte until the byte is mechanically accepted by the 1052.

Sense Lights - See Figure 34.

Cmnd Rej: This light indicates that an invalid command has been given.

Intvtn Req: This light indicates that the 1052 is not ready.

Bus Out: This light indicates that a parity error was detected on the channel bus out.

Equip: This light indicates a keyboard parity error, an error in the data path between the keyboard and the printer, or a mechanical malfunction in the printer.

Proc Light - This light indicates that a read command has been initiated and the keyboard is unlocked.

Attn Light - This light indicates that the request key has been depressed, and the 1052 is waiting for the attention to be accepted.

CE Mode/On-line Switch - For normal operation, this switch must be in the on-line position. When maintenance is required, the switch is placed in the CE mode position, which prevents data from being gated to the 1052 and causes the select out signal to be generated.

Contin Write/Read Switch - This switch is used in conjunction with the CE mode position of the CE mod/on-line switch. Both positions

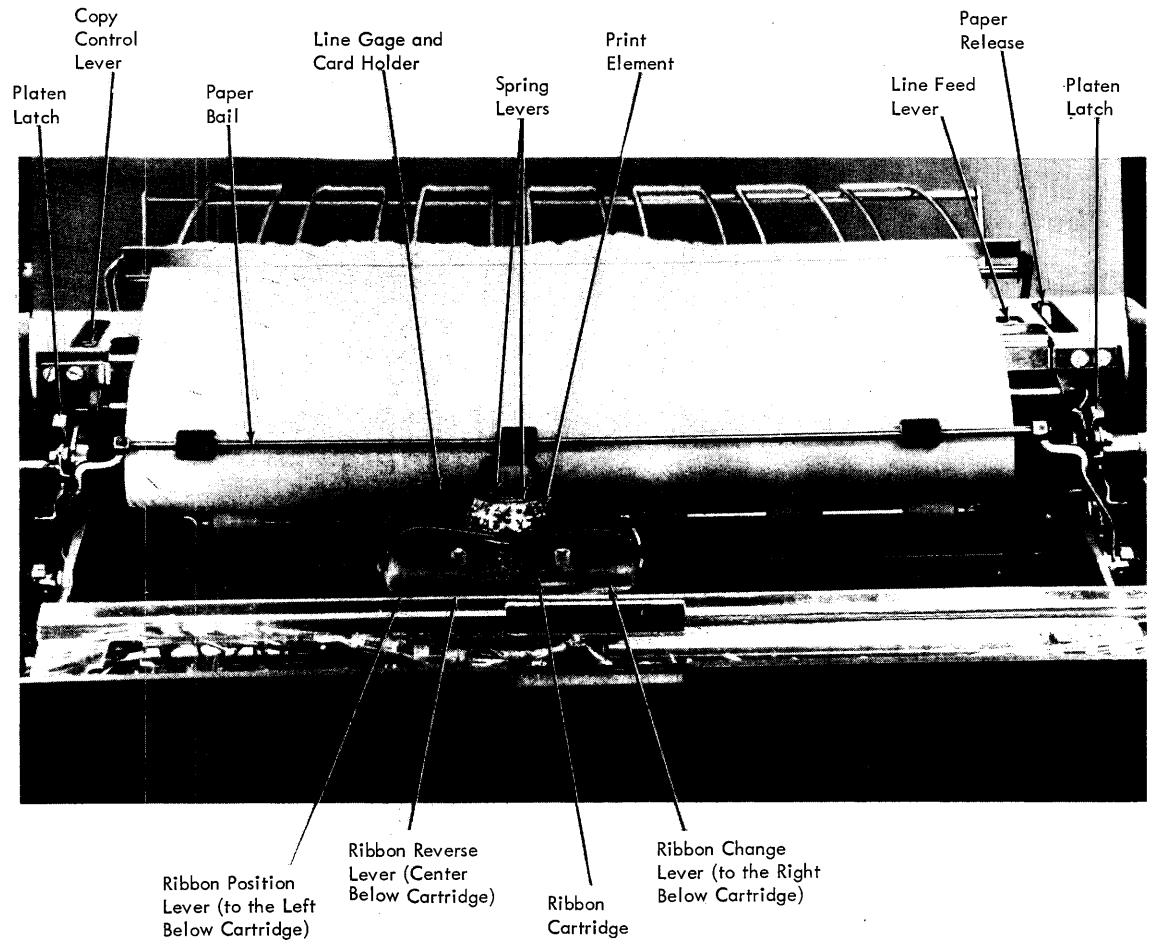


Figure 35. Printer Controls

of the contin write/read switch are for testing purposes; therefore the switch is used only by customer engineering personnel.

Print Position Indicator - Two blue pointers indicate the left and right margin stop positions. A white pointer indicates the position of the print element carrier.

Printer Controls

These controls (Figure 35) permit the operator to control the 1052 printing operations.

Copy Control Lever - This lever controls the print element-to-platen clearance for best printing results with single or multiple-copy forms. The lever is set to the second mark for a three-carbon form and to the third mark for a five-carbon form.

Line Feed Select Lever - This lever controls vertical line spacing of the platen for either single or double line spacing.

Paper Release Lever - This lever enables the removal and repositioning of the paper. Moving the lever towards the operator releases the roller tension from the platen.

Platen Latch - These latches permit removal of the platen (press both latches and lift out the platen).

Paper Bail - The paper bail holds the paper against the platen. To remove or insert paper, the bail must be moved away from the platen.

Print Element and Spring Levers - The spring levers enable removal of the print element. Pinch the levers together to release the printing element, and lift the element out.

Ribbon Cartridge - The ribbon cartridge contains the printer ribbon.

Ribbon Position Lever - The four-position lever (left to right) permits the ribbon to be positioned so that either the bottom (red), middle (red-black), or top (black) section of the ribbon is used. The fourth position (extreme right) is used for stencil operations. Periodic repositioning of this lever extends the life of the ribbon and permits the used portions of the ribbon to be re-inked. This lever is black and is located directly below the left-center of the ribbon cartridge and slightly in front of it.

Ribbon Reverse Lever - This lever permits the operator to reverse the direction of the ribbon before reaching the end of the ribbon. The ribbon automatically reverses when either end of the ribbon is reached. This lever is black and is located directly below the center of the ribbon cartridge and slightly in front of it.

Ribbon Change Lever - Moving this lever to the extreme right lifts the ribbon guide and permits easy removal of the ribbon and ribbon cartridge. This lever is black and is located directly below the right center of the ribbon cartridge and slightly in front of it.

Margin Set Controls - These controls (Figure 36) enable the adjustment of the left and right margin stops.

Keyboard Controls

These controls (Figure 33) permit the operator to manually enter data into the system.

Alt'n Coding Key

This key is not functional.

Enter

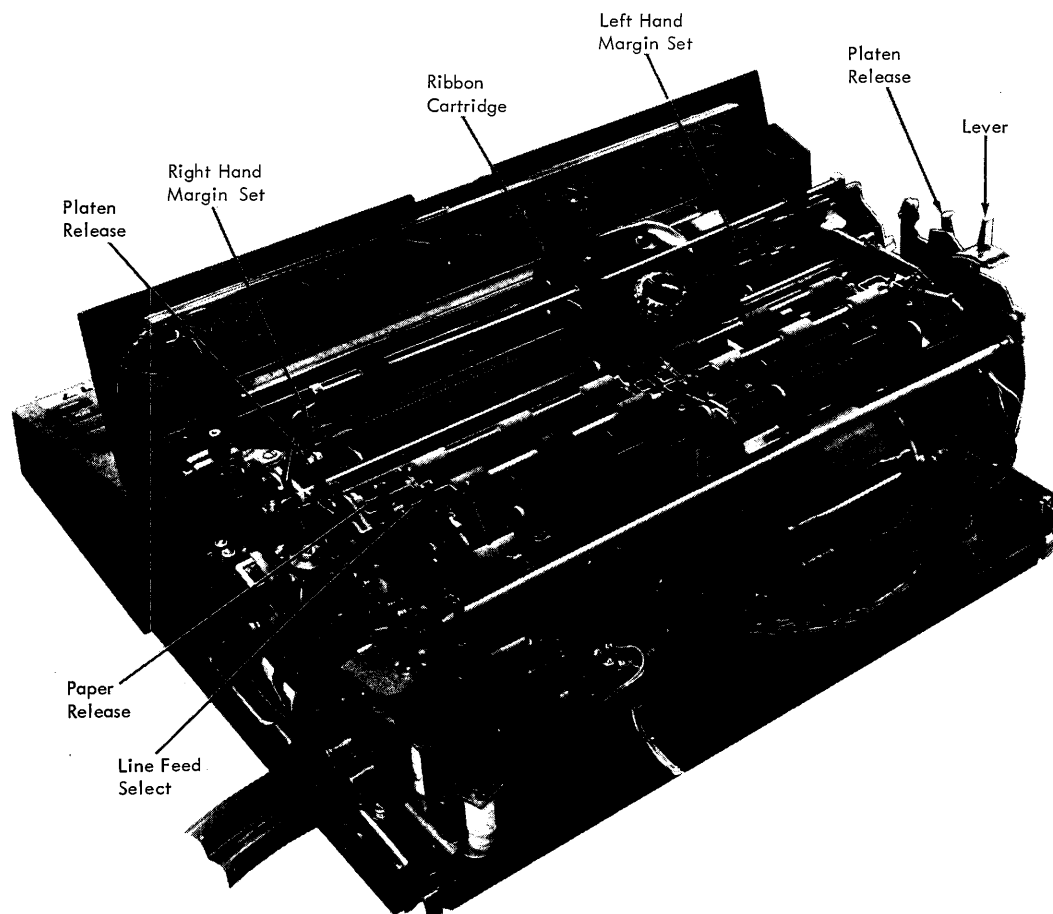


Figure 36. Margin Set Controls

Depression of this key signals the adapter to terminate the Read operation normally.

Cancel - Depression of this key signals the adapter that the message is in error and the Read operation is terminated abnormally.

Tab Key - Pressing this key moves the print element carrier to the next tab stop to the right.

Shift and Lock Keys - Pressing either of the shift keys (both shift keys are locked together) positions the print element for upper-case printing. Pressing the lock keys locks the print element in the upper-case position. To release the print element from the locked upper-case position, depress and release either shift key.

Backspace Key - Pressing this key causes the print element to move one space towards the left margin. It is necessary to successively press and release the key for each space required.

Line Feed Key - Pressing this key causes the platen to line space vertically.

Return Key - Pressing this key causes the print element to return to the left margin stop and the platen to line space vertically.

Space Bar - Pressing this bar causes the print element to move one space towards the right margin.

Alphabetic Keys - If the shift or lock key is not depressed, pressing one of the alphabetic keys causes the corresponding lower-case letter to be selected. Pressing the same key with either the shift or lock key depressed causes the corresponding upper-case letter to be selected.

Special Character Keys - If the shift or lock key is not depressed, pressing one of the special character key causes the lower character marked on the key to be selected. Pressing the same key with either the shift or lock key depressed causes the upper character marked on the key to be selected.

Numerical Keys - If the shift or lock key is not depressed, pressing one of the numerical keys causes the corresponding number to be selected. Pressing the same key with either the shift or lock key depressed causes the special character marked on the upper portion of the numerical key to be selected.

Tab Control - This switch (Figure 34) in conjunction with the space bar, enables a tab stop to be set (set) or cleared (clear) at any printing position.

OPERATOR'S GUIDE

Setting the Margin Stops

1. Center the print element with the space bar.
2. Lift the top cover, and tilt the hinged indicator panel toward the operator.
3. Press the blue margin stop set controls toward the operator and slide to the desired position (Figure 36).
4. Close the top cover, and verify the margin stop positioning in the print position indicator (Figure 34).

Setting and Clearing the Tabulate Stops

1. Position the carrier to the desired position with the space bar. Observe the print-element carrier pointer in the print position indicator (Figure 34).
2. Depress the set position of the tab control to set the tabulate stop, or depress the clear position to clear the tabulate stop.

Making A Keyboard Entry

1. Set the margin and tab stops as required.
2. Position the print element to the desired position between the left and right margin stops. Observe print-element carrier pointer in the print position indicator for correct positioning (Figure 34).
3. Depress the ready key (Figure 33).
4. Depress the request key. The attn light will come on, indicating that a request has been initiated but not accepted by the system.
5. When the system accepts the request, the attn light is turned off, and the procd and read lights are turned on (Figure 34).
6. Make desired keyboard entry by depressing appropriate keys (Figure 33). A printout occurs for each character entry.

NOTE: To cancel an entry, perform steps 7-9. Otherwise, perform steps 10 and 11.

7. Depress the cancel key (Figure 33). This cancels all entries made during this request.
8. The procd light will turn off momentarily, but it will come back on.
9. Re-enter the entire message. It is not necessary to depress the request key again.
10. After the entry is completed, depress the enter key (Fig. 33). This notifies the system that the entry is complete.
11. The read and procd lights are turned off when the keyboard entry and EOB operations are completed.

Changing the Ribbon Cartridge

1. Center the carrier with the space bar.
2. Lift the top cover, and tilt the indicator panel toward the operator.
3. Move the ribbon change lever to the extreme right to raise the ribbon guide (Figure 37).
4. Lift the ribbon cartridge straight up, and ease the ribbon out of the slots in the ribbon guide.
5. Rewind the excess ribbon by inserting a wooden pencil in either of the cartridge holes, and turn in the direction of the arrow.
6. Position the new cartridge with the exposed ribbon facing the platen.
7. Slide the ribbon through the slots in the ribbon guide.
8. Position the cartridge on the cartridge posts, and press into place.
9. To rewind excess ribbon, turn either cartridge post in the direction of the arrow.
10. Move the ribbon change lever to its extreme left position. This lowers the ribbon guide into proper typing position.
11. Close the top cover.

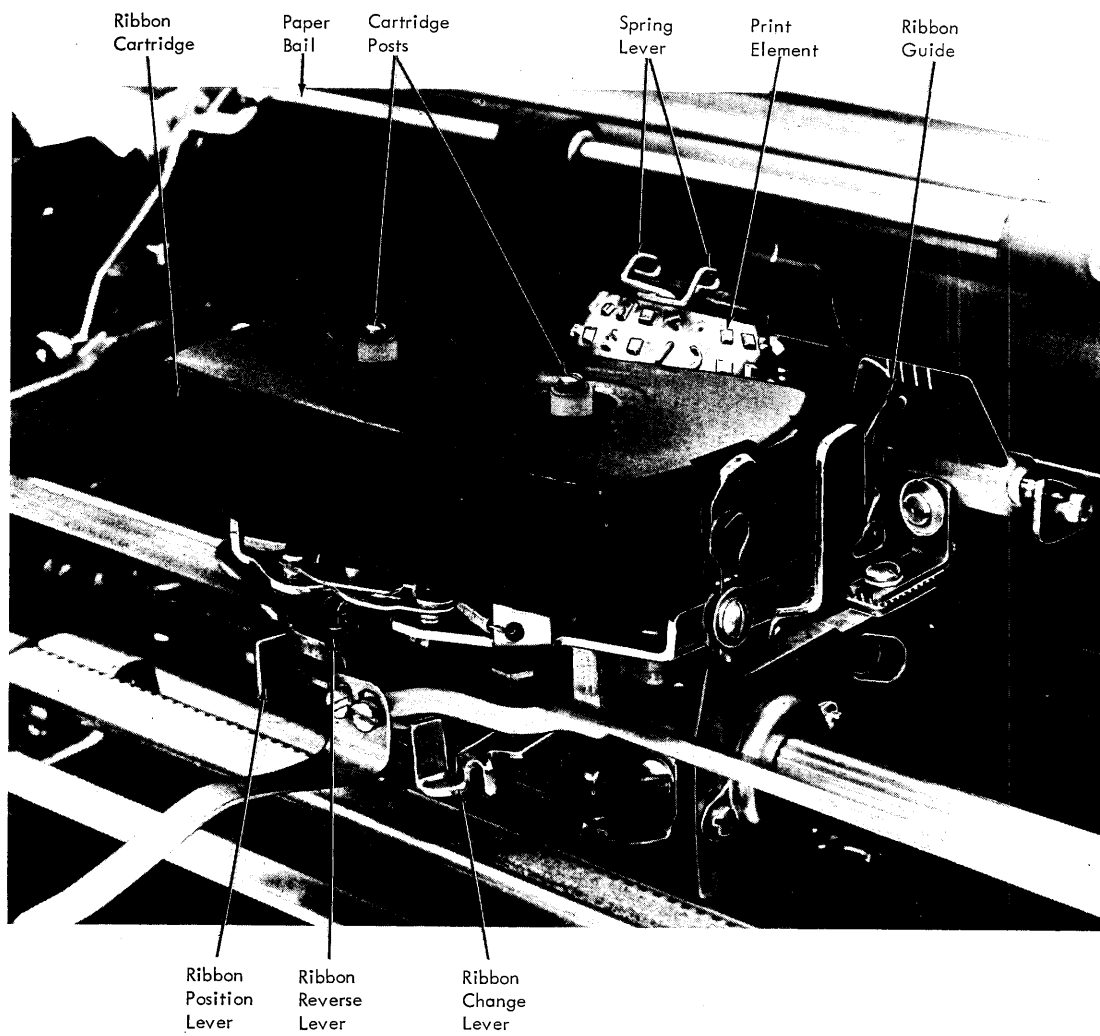


Figure 37. Ribbon Cartridge

IBM 2401 MAGNETIC TAPE UNIT

The IBM 2401 Magnetic Tape Units (Figure 38) provide magnetic tape input and output capabilities for the IBM 9020 System. Presently, Models 2 and 3 are used with the 9020. The models differ with each other primarily in the speed at which tape can be moved past the read-write heads (data rate). The data rates for Models 2 and 3 are 60,000 and 90,000 bytes per second (bps), respectively. Both models have a byte density of 800 bytes per inch (bpi).

Magnetic Tape

The magnetic tape used with the IBM 2401 Magnetic Tape Units is made of plastic material coated with a metallic oxide. The tape is wound on a 10-1/2 inch diameter plastic reel (Figure 39). A full reel contains approximately 2400 feet of usable tape; however, lengths as short as 50 feet can be used. Three windows in the sides of the reels show the amount of tape remaining on a reel. One of the windows on the front of the reel has four marks to aid the operator in estimating the amount of tape on a reel. Each mark indicates approximately 400 feet of tape.

Tape Markers

Two reflective markers are provided at each end of the tape. The tape unit senses the markers as either the load point (where reading or writing is to begin) or as the end-of-tape marker (approximately where writing is to stop). The end-of-tape marker is recognized by the tape unit during a forward tape operation. A tape mark written on the tape signals an end-of-file condition.

File Protection Device

A write operation automatically erases any data previously written on the tape; therefore, a file protection device is provided to prevent accidental erasure of data to be saved. This device is a plastic ring (Figure 40) that fits in a circular groove molded in the back (machine side) of each tape reel. With the ring in place, data can be either written or read. When the ring is removed, data cannot be written on the tape but the data can be read for processing.

Reading and Writing Magnetic Tape

Figure 41 shows the arrangement of the tape and reels. During reading or writing, tape moves from the file reel, through the left vacuum column, across the read/write head, through the right vacuum column to the machine reel. The tape loop in each vacuum column acts as a buffer for the sudden start and stop motion of the tape. The two tape reels rotate independently. The file reel feeds tape when the tape loop reaches a minimum reserve length in the left vacuum column, and the machine reel winds tape when the loop reaches a point near the bottom of the right vacuum column.

Writing or reading takes place as the tape is moved across the read/write head (Figure 42) -- writing at the write gap, reading at

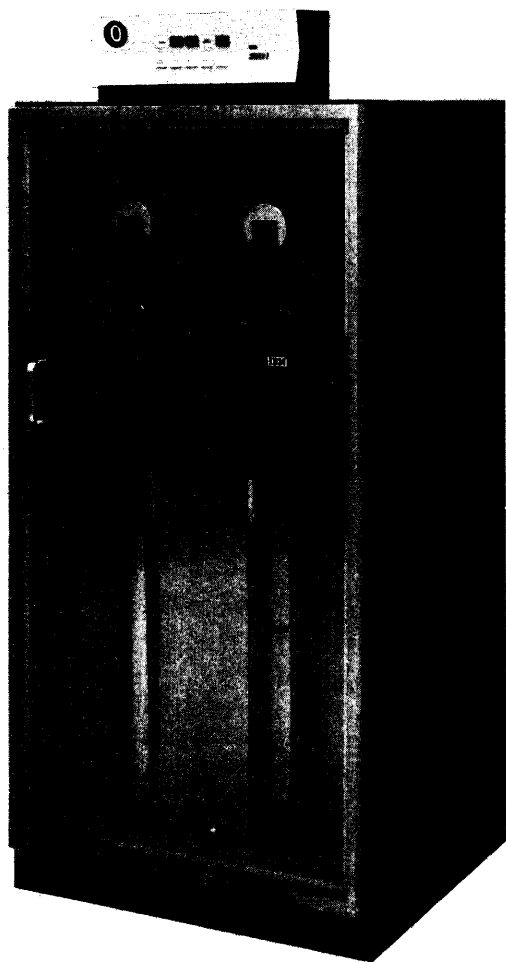


Figure 38. IBM 2401 Magnetic
Tape Unit

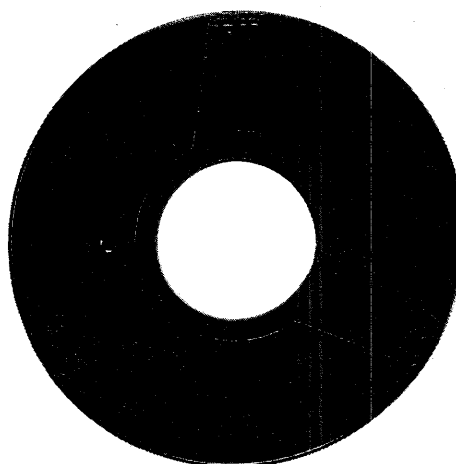


Figure 39. Magnetic Tape Reel

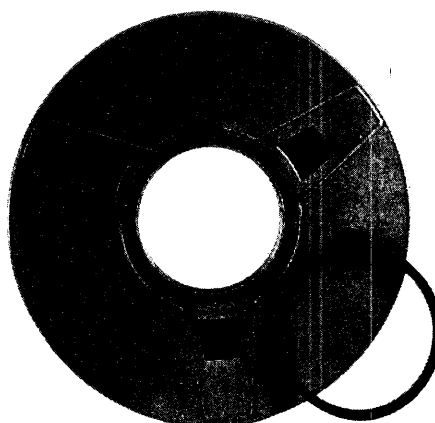


Figure 40. File Protection Ring

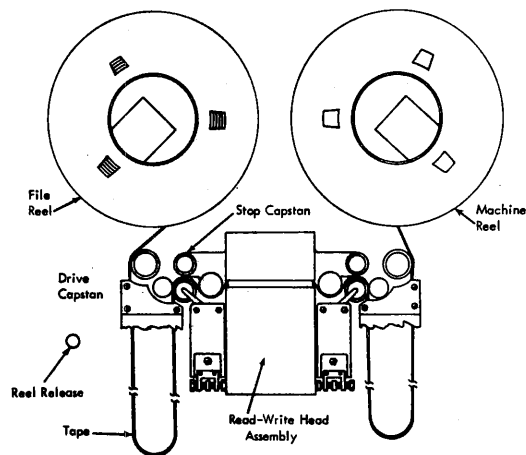


Figure 41. Tape and Reel Arrangement

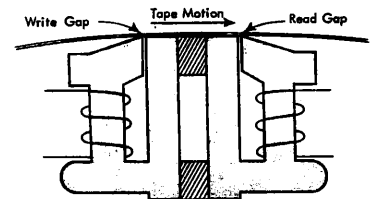


Figure 42. Read/Write Head

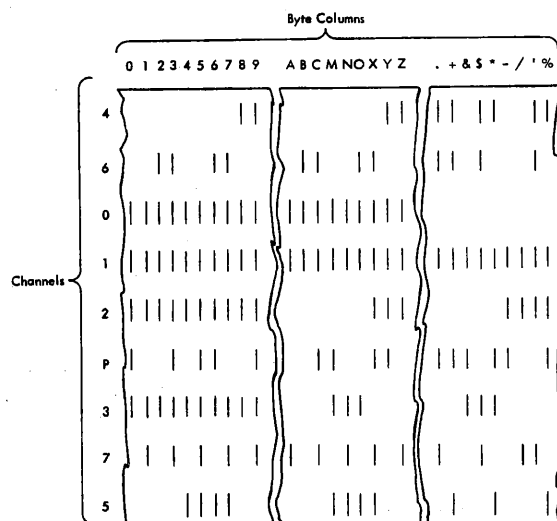


Figure 43. Tape Data Format

the read gap. Information is normally written on tape by magnetizing small areas in nine parallel channels (Figure 43). When the seven-track compatibility feature is installed in the control unit, the 2401 Magnetic Tape Units Models 2 and 3 (with seven-track read/write heads) can read or write tape in the format used by the IBM 729 and 7330 Magnetic Tape Units.

Tape validity is checked during the read part of the write operation or during a read operation by reading information on tape at the read gap. With the two-gap head, information may be read for checking immediately after writing. Reading tape for checking purposes, as part of a write operation, is referred to as a read back check. Checking during a read operation is known as a read check.

Tape Blocks

Data is written on tape in the form of blocks, with each block consisting of one or more bytes. Each block is separated by 0.6 inch of blank tape called an interblock gap (IBG). The IBG is automatically produced at the end of a block when writing.

Reading of tape begins with the first byte after an IBG and continues until the next IBG is sensed.

A tape file, consisting of one or more blocks, is identified by an IBG followed by a single byte block. This byte, called a tape mark, appears at the end of the file of information. One or more files can be written on a reel of tape.

Operation Control

In the 2401, almost all operations are program controlled. The program executes a basic I/O instruction that causes the input-output control element (IOCE) to generate a channel command word (CCW). The CCW then controls the actual tape unit operations. Some major program-controlled operations are:

Write Operation

The program selects a specific tape unit and generates a CCW. The CCW causes the tape to move past the read/write head, and data fetched from specified storage locations are written on the tape.

Read Operation

The program selects a tape unit and generates a CCW. The CCW moves the tape and transfers the data read into specified storage locations. Reading starts after the first IBG and stops when the next IBG is sensed.

Read Backward Operation

The program selects a tape unit and generates a CCW. The CCW moves the tape in a backward direction and transfers data into specified storage locations in the reverse order in which the data was written.

Rewind Operation

The program selects a tape unit and generates a CCW. The CCW causes the tape to rewind to the load point.

CONTROLS AND INDICATORS

The 2401 controls and indicators (Figure 44) can be functionally separated into two groups: machine controls and machine indicators.

Machine Controls

These controls permit the operator to perform such functions as re-winding the tape unit to load point, unloading the tape unit, and making the tape unit either ready or not ready.

Load-Rewind Key - Pressing this key initiates a tape loading or a re-wind operation. The load-rewind key is operative only when the reel door is closed and the ready light is off. Use of this key after tape is properly mounted in the magnetic tape unit lowers tape into the columns, lowers the head assembly, and moves tape in the rewind direction until the load point reflective marker is sensed. The purpose of this key is to set the tape into the machine at the starting point (load point), ready for either reading or writing.

Use of the load-rewind key with tape loaded and the machine reel containing more than one-half inch of wound tape, initiates a high-speed rewind operation. The amount of tape to be rewound is measured automatically by a light-beam and photocell mechanism in the tape unit. Tape is removed from the columns, the head assembly is raised, and tape is rewound at high speed until less than one-eighth inch of wound tape remains on the machine reel. Tape is then lowered into the columns, the head assembly is lowered, and a low-speed rewind continues until the load point marker is sensed.

Use of the load-rewind key with tape loaded and the machine reel containing less than one-half inch of wound tape initiates a low-speed rewind until the load point marker is sensed.

CAUTION: Do not open the reel door while tape is searching for load point or during a rewind operation. This could cause breakage or damage to the tape.

Start Key - This key places the tape unit in ready status and turns on the ready light if:

1. Reel door is closed.
2. Tape is loaded into the columns.
3. Tape unit is not in the process of finding load point (rewind or load point operation).

Pressing the start key disables all manual controls.

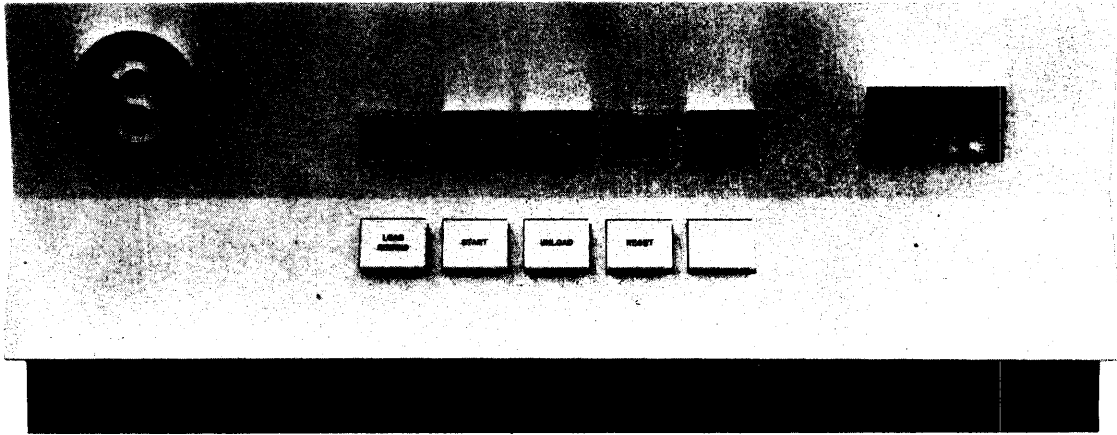


Figure 44. Operator's Controls and Indicators

Unload Key - This key initiates a tape unload operation. The unload key is operative only when:

1. Ready light is off.
2. Tape is in columns.
3. Reel door is closed.

Use of this key raises the head assembly and removes tape from the columns, regardless of the distribution of the tape on the two reels. If the tape is not at load point when the operator wishes to change tape reels, a load point search should be initiated by pressing the load rewind key. Pressing the unload key also turns off the tape indicate light, if on.

Reset Key - This key resets the tape unit from ready status. In this condition, no operations can be performed through the tape control. The reset key is used to return the tape unit to manual control. Pressing the key removes the machine from ready status, if it has not already been removed, and stops whatever machine operation is in progress, except for unload and rewind. The unload operation is always completed, once started; the high-speed rewind operation is shifted into low-speed rewind. After the tape is loaded into the vacuum columns and low-speed rewind is in progress, press the reset key again to stop the low-speed rewind.

Reel Door Interlock - This interlock automatically prevents any normal operation of the tape unit when the door is open. The reel door

should never be opened when the ready light is on or during any load-rewind operation.

Reel Release - Depressing this key (Figure 40) permits the reels to be turned manually for threading tape when the reel door is open.

Machine Indicators

These indicators permit the operator to monitor the operational status of the tape unit.

Select Light - This light (Figure 44) is turned on automatically when the unit is addressed by the computer. The addressed tape unit must be ready before it can be instructed by the program.

Ready Light - When this light is on, it indicates that the tape unit is properly loaded, the start key has been pressed, and the tape unit can now be activated through the tape control. The ready light is turned on by pressing the start key if:

1. Tape unit is loaded (tape in columns.)
2. Reel door interlock is closed.
3. Tape unit is not in the process of finding load point.

Pressing the start key while the tape is in motion, as in a load-rewind operation, does not light the ready light until the load rewind is completed. The reel door should not be opened when the ready light is on. Manual control is indicated when the ready light is off, if the tape unit is not rewinding or loading, and the reel door is closed.

File Protect Light - When this light is on, it indicates that the loaded tape unit is file protected; that is, neither writing nor erasing can take place on this tape unit. The file protect light is on when:

1. No file reel is mounted.
2. A file-protected tape reel is in progress.
3. A load-rewind operation is in progress.
4. An unload operation is in progress.

The indicator is turned off by mounting a tape reel that is not file protected. If the file protection ring has been removed and this light fails to go on, notify the customer engineer.

CB Light - When this light is on, it indicates that a circuit breaker has been tripped. The tape unit cannot operate until the circuit breaker has been reset by a customer engineer.

Tape Indicate Light - When this light is on, it signifies that an end-of-tape marker has been sensed during a forward tape operation. The tape indicate light is turned off by pressing the unload key or when the tape unit receives a rewind, rewind/unload or backward command.

OPERATOR'S GUIDE

General Precautions

The following precautions should be observed for efficient operation of IBM 2401 Magnetic Tape Units.

1. Caution should be taken by a person who is smoking while handling tape, attending the tape units, or working in the tape storage area. Ashes can contaminate tape, and live ashes can produce permanent damage if they touch the surface of the tape.
2. Do not use the top of a tape unit as a work area. Placing things on the tape unit exposes them to heat and dust from the blowers in the unit, and may interfere with the cooling of the unit.
3. Inspect the tape-reel containers periodically. To remove any accumulated dust, wash the containers with a regular household detergent.
4. Clean Mylar* tape by wiping it gently with a clean, lint-free cloth moistened with an IBM-recommended tape transport cleaner. This cleaner must never be used on IBM heavy duty (HD) magnetic tape; however, HD magnetic tape can be cleaned by wiping with a dry cloth only. Do not use carbon tetrachloride or IBM cleaning fluid for cleaning any magnetic tape.
5. The regularity with which tape drives must be cleaned depends on the amount of usage they receive. Generally speaking, if tape drives are heavily used, they should be cleaned once each eight-hour shift and before each long sort. The most important parts to clean are: the read/write head, rubber rollers that move in and out as the tape is loaded and unloaded. The other metal, plastic, and hard rubber rollers that move in and out as the tape is loaded and unloaded. The other metal, plastic, and hard rubber rollers (both stationary and moving) should be cleaned regularly.
6. When handling tape reels, always avoid pinching the reels, or contacting the exposed edge of the turns of the tape.
7. When the file-protection ring is required, be sure it is inserted properly. If it is not, the reel may wobble and cause the tape to unwind unevenly, thus damaging the edges.
8. Never turn the power off when the tape is loaded in the vacuum columns and the head assembly is closed. Opening the assembly to remove tape requires power, and tape may be damaged if power is turned on with tape in the columns. Extraneous noise may be recorded on the tape when power is reapplied.
9. If a power failure occurs when tape is loaded in the vacuum columns, have a customer engineer remove the tape from the head assembly and columns before power is restored.
10. During a high-speed rewind, do not open the reel door until rewinding is completed. This could place undesirable tension on the tape and damage the tape. If an emergency forces you to do so, take these steps:

* Trademark of E. I. duPont de Nemours Company (Inc)

- a. Press the reel-release button and wind at least 200 feet of tape from the file reel onto the take-up reel.
 - b. Close the reel door.
 - c. Resume the high-speed winding.
11. Make absolutely sure that data on a reel of tape is no longer active and may be destroyed, before you insert the file-protection ring in the reel. Carelessness can destroy valuable records.
12. When removing the file-protect ring, do so carefully. Never, under any circumstances, demount the tape reel from the tape unit to remove the ring while tape is loaded in the vacuum columns.

Tape Load Procedure

1. Mount the reel to be loaded on the left mounting hub and close the hub latch. Place the hub of the reel firmly against the stop on the machine mounting hub to insure proper alignment. If the reel is not properly aligned, it may fail to feed the tape smoothly, and read or write errors may occur. Also, during rewind, the tape will not wind correctly, and edges of the tape will be exposed. Always be careful that the hub latch is closed.
Be careful not to fold or wrinkle the end of the tape on the take-up reel, because this would probably cause the tape to wind unevenly on the take-up reel.
2. Hold the reel release key (Figure 41) depressed and rotate the file reel clockwise, unwinding about 6 feet of tape.
3. Place the tape over the left roller, through the read/write assembly, and over the right roller. Place and hold the end of the tape between the index finger and the hub of the machine reel. Press the reel release key and wind tape on the machine reel clockwise for at least two turns beyond the load point marker. Align the tape carefully on the machine reel to prevent damage to the edge on the first few turns. Use the reel finger hold when winding the tape. Rotating the reel using the cut out area can result in damage to the edge of the tape.
4. Close the reel door.
5. Press the load rewind key. This load tape into the vacuum columns, lowers the head assembly, and rewinds tape to load point.
6. Press the start key. This places the tape unit under automatic control and turns on the ready light.

Tape Unload Procedure

1. If the ready light is on, press the reset key to return the unit to manual control.
2. Press the load rewind key to rewind the tape.
3. When the load point is reached, press the unload key.
4. Open the reel door when the head assembly is fully raised and the tape is out of the columns.

5. Hold the reel release key depressed and manually rewind the file reel by turning it counterclockwise with the finger pressed in the finger hold of the tape reel.

Note that if an unloaded tape is to be reused, leave about three turns of tape on the take-up reel. This prevents the lead end of the tape from coming off the take-up reel when the tape is reloaded and the tape drive is searching for the load-point reflective marker.

6. When the tape is completely rewound, open the hub latch and remove the reel. If resistance is encountered in removing the reel, exert pressure from the rear of the reel with the hands as near the hub as possible. Never rock a reel by grasping it near the outer edge in a way that pinches the outer edges of the outer turns of the tape.

Damaged Tape Reels

If a reel of tape is dropped, the reel may be broken or deformed. Deformation, however, is less likely, because a strain sufficient to deform a reel usually breaks it. Inspect the reel immediately. Breaking or deforming of the reel can usually be found visual inspection. In addition, check the reel for deformation by mounting it on the hub of a tape unit. If the reel has been deformed or broken, it must not be used again. The tape itself may be serviceable or it may be crimped and/or soiled.

If there is no evidence of crimping or other tape damage, and the reel is undamaged, thoroughly clean both the reel and the unwound portion of tape.

If the tape appears undamaged but the reel is damaged, clean the unwound portion of tape, and wind the tape onto a good reel by following the steps described below.

NOTE: When the data on the tape does not have to be saved, perform steps 1-7. When the data on the tape must be saved, perform steps 2-6 and steps 8-11.

1. Position the reflective marker about 14 feet from the end of the tape.
2. Remove the take-up reel.
3. Mount the damaged reel backwards (file protection ring facing outward) on the take-up hub.
4. Mount an empty reel on the file hub.
5. Thread the tape onto the empty reel and load the tape.
6. The tape will go into a high-speed rewind, and when the rewind is completed, the tape will be properly wound onto a good reel.
7. Demount the reel from the file hub, destroy the reel on the take-up hub, and mount a good reel on the take-up hub.
8. Remove the good reel from the file hub and mount it backwards on the take-up hub.
9. Place an empty reel on the file hub.
10. Thread the tape onto the empty reel and load the tape.

11. The tape will go into a high-speed rewind, and when the rewind is completed, the tape will be wound properly on the reel of the file hub.

If the reel and a portion of the tape are damaged, the undamaged portion of the tape may be salvaged. When the tape does not contain data that must be saved, cut off the damaged portion and wind the tape onto a good reel by performing steps 1-7.

When crimped tape contains essential data, thoroughly clean the tape and attempt to reconstruct this data by performing a tape-to-printer operation. Then write the data onto a new tape. If reconstruction fails, the tape records must be rewritten from the original source material.

Tape Handling

1. Before storing tape reels, place sponge rubber grommets or plastic strips on the reel to prevent the free end of the tape from unwinding in the container. Do not use adhesive-type tapes (such as cellophane or masking tape) for this purpose because, when removed, they leave a sticky residue on the magnetic tape.
2. Keep each reel of tape in a dustproof container when it is not in use on a tape unit. When a reel of tape is to be used, take it directly from its container and place it on the tape unit, immediately replace it in a container. While a reel of tape is on a tape unit, keep the container closed tightly to minimize the accumulation of dust in the container.
3. Store tape-reel containers in a cabinet elevated from the floor and away from paper and cards, which may be sources of dust. This should minimize the transfer of dust from the outside of the container to the reel during loading or unloading operations.
4. Any time tape-loaded reels are shipped, they should be placed in their plastic containers and sealed in a plastic bag. Additional protection should be provided by packing in stiff cardboard shipping cartons.
5. If tape is to be stored for long periods of time, the following conditions are recommended:

	<u>Relative Humidity</u>	<u>Temperature</u>
Mylar tape	20% - 80%	50° - 90°F
Heavy Duty tape	20% - 80%	40° - 120°F

Tape that has been exposed to other conditions should be reconditioned to the operating environment of the machine room for a length of time equal to the time it was outside the recommended conditions (to a maximum reconditioning period of 24 hours). Reels of tape should always be stored vertically in their plastic containers when not in use. Stored tapes must also be kept out of a strong magnetic field area.

6. To label a reel of tape externally for identification, use a material that can be removed without leaving a residue. Adhesive stickers that can be applied and removed easily are most satisfactory. Never use an eraser to alter the identification on a label.

Installing Tape Markers

A certain amount of blank space must be left at the beginning and end of a reel of tape to allow threading through the tape unit feed mechanism. Both the beginning and the end of usable tape are identified by reflective markers. The markers are small pieces of transparent plastic with a thin film of aluminum on one side. The markers are manually fastened to the base (uncoated side) of the tape by a pressure-sensitive adhesive covering on the markers.

Care must be taken when applying the reflective markers to the tape. Trouble may result if the tape is soiled or damaged in this process. If possible, apply the reflective markers while the tape is mounted in a tape unit. If the markers are applied while the tape is away from the tape unit, keep the unrolled end of the tape off the floor and away from dusty areas.

Load Point Marker

At least 10 feet of tape must be allowed between the beginning of the reel and the load point marker as a leader for threading the tape on the tape unit. More than 10 feet may be allowed by placing the marker any desired distance from the beginning of the reel. To indicate the load point, the marker must be parallel to and not more than 1/32 inch from the edge of the tape nearest the operator when the reel is mounted.

End of Tape Marker

About 14 feet of tape are usually reserved between the end-of-tape marker and the end of the tape. This space includes at least 10 feet of leader and 4 feet for the recording of data after the end-of-tape marker is sensed. During writing, the end-of-tape reflective marker indicates the end of tape. The marker is placed parallel to and no more than 1/32 inch from the edge of the tape nearest the tape unit when the tape is mounted.

IBM 2312/2318 DISK STORAGE UNIT

The IBM 2312 and 2318 Disk Storage Units (DSU) (Figures 45 and 46) provide disk input and output capabilities for the IBM 9020 System. The 2312 Model A1 and 2318 Model A1 are available to be used with the 9020 System. The 2312 contains one disk drive module and the 2318 contains two disk drive modules. Other than that, the two units are operationally identical. The data transfer rate for the units is 312,000 bytes per second. The storage capacity per disk drive module is 29.176 million bytes.

IBM 2316 Disk Pack

The IBM 2316 Disk Pack (Figure 47) is used with the 2312 and 2318 Disk Storage Units. The Disk Pack can be quickly removed from or mounted in any of the disk drive modules. The Disk Pack consists of 11 metal disks having 20 surfaces coated with a metallic oxide. Each of these surfaces contains 200 tracks (plus 3 alternates) on which the data is recorded in bit serial fashion. Each of these tracks may contain a maximum of 7,294 bytes of data. The 20 surfaces, therefore, provide a maximum total storage capacity for the Disk Pack of 29.176 million bytes.

File Protection

No physical file protection device exists for Disk Packs. The protection of data recorded on the disk is handled by the program.

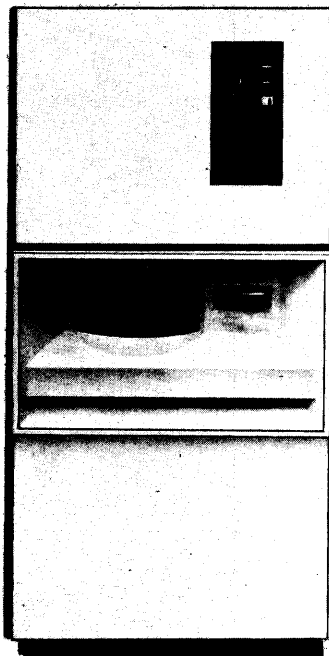
Reading and Writing on Disk Packs

The 2316 Disk Pack must be turning to accomplish reading or writing. The speed of rotation is 2400 RPM (25 ms. per revolution). The Read/Write heads are mounted on the ends of the access arms. There is one Read/Write head per disk surface. When the disk is rotating at operating speed, the heads are loaded and are forced toward the oxide surface under spring tension. The shape of the head and the rotational speed of the disk prevent the head from touching the oxide surface. The heads, therefore, "fly" in close proximity to the recording surface. The heads may be positioned, along a radial, to any one of 203 discrete positions (tracks) and then one of the 20 heads is selected. These operations are accomplished under program control. Once positioned, the desired data record is located on the track. When the record is located, reading or writing of data can then take place.

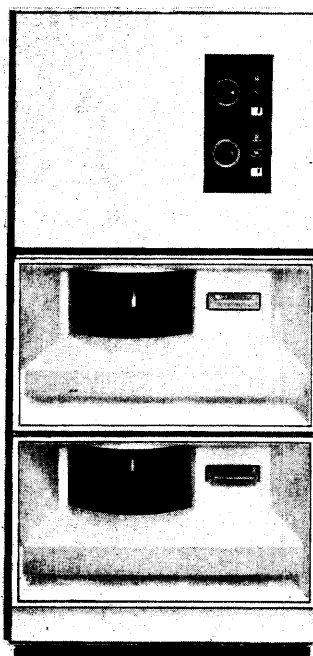
Data Records

A sensing device mounted in the disk drive module is activated once per revolution of the disk pack. This provides a physical reference point for the start of each data track.

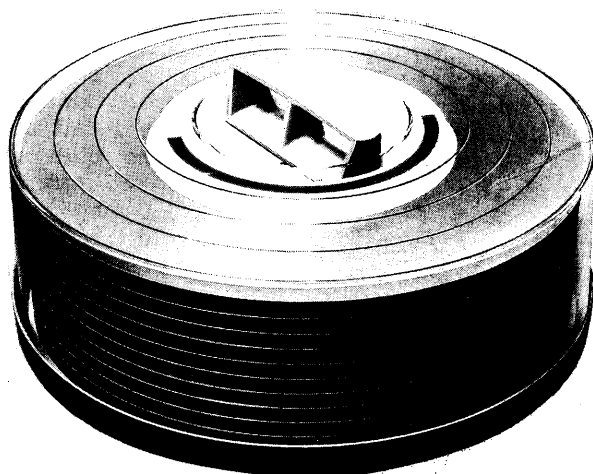
July 1, 1971



• Figure 45. IBM 2312 Disk Storage Unit



• Figure 46. IBM 2318 Disk Storage Unit



• Figure 47. IBM 2316 Disk Pack

Each track can have an address recorded at its start that identifies it from all other tracks on that disk pack. Each data record on a track includes an identifier that distinguishes that record from the others on that track. Multiple records may be written on each track and multiple files may be written on each disk pack.

Operation Control

In the 2312 and 2318, almost all operations are program controlled. The program executes a basic I/O instruction that causes the Input Output Control Element (IOCE) to access storage for a Channel Control Word (CCW). The CCW then identifies the type of operation which is to take place at the Disk Storage Unit. Some of these program-controlled operations are:

Seek Operation

This operation causes the selection of the desired Read/Write head and physically positions it over the desired track.

Search Operation

This operation compares an identifier provided by the program with identifiers read from the track on the disk pack. An indication is provided to the program that the desired area has been located.

Write Operation

This operation causes data or identification information which is fetched from specific storage locations to be written on the disk pack.

Read Operation

This operation causes data or identification information to be read from the disk pack into specified storage locations.

Controls and Indicators

The controls and indicators for the 2312 and 2318 Disk Storage Units are identical. They are located on a control panel (Figure 48) above the disk drive module drawers.

Module Identifier Plugs

Each of the disk drive modules has a module identifier plug receptacle. If a module does not have a module identifier plug in this receptacle, then that module is not logically attached to the control unit and cannot be controlled by the program. If a module identifier plug is placed in the module's receptacle, the access mechanism of that module is positioned at cylinder 000 and a not-ready-to-ready-sequence device end is then presented to the channel from the control unit. The affected module is then in the same physical and logical state as if its disk pack had been changed and then the module made ready, or in the same state as when the system is initially powered on.

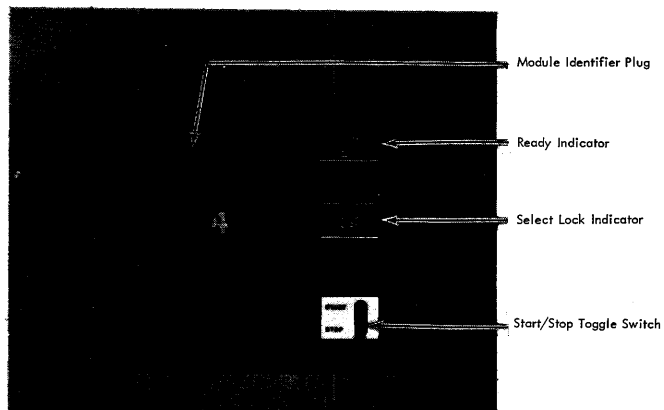


Figure 48. 2312/2318 Operator's Controls and Indicators

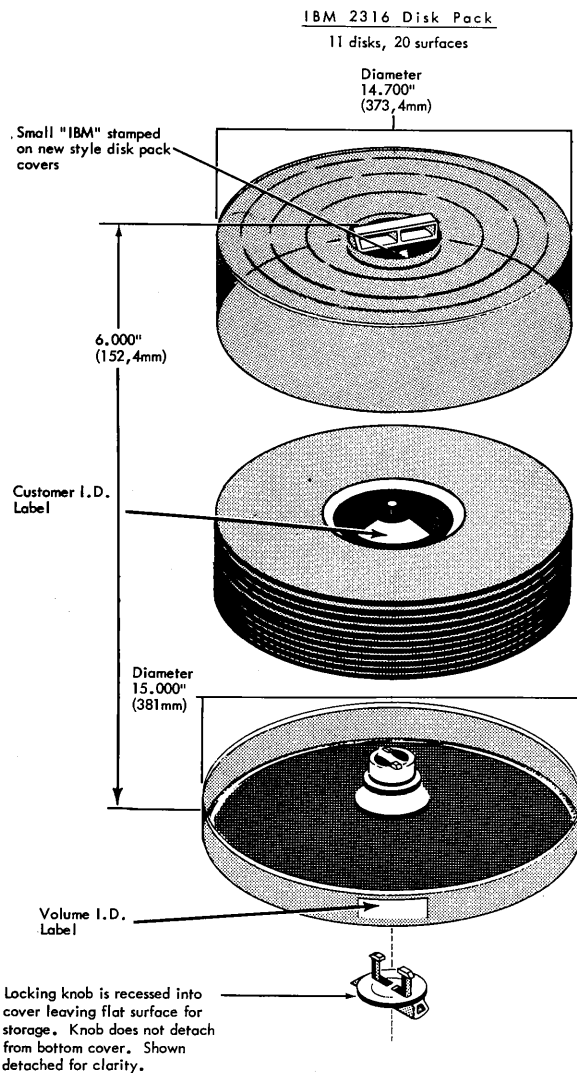


Figure 49. IBM 2316 Disk Pack Assembly

Each removable module identifier plug has a unique address which is one of the values in the range 0 through 7. The printed address on each identifier plug is in decimal notation and represents the four low-order bits of the device address. A module identifier plug for maintenance is provided which is labeled "S". To change the address of a module, remove its module identifier plug and insert the plug that has the desired address. Always ensure that the module plug is completely in or completely out; not left part way out. (See Changing a Module Address.) Local installation practices must determine which 2316 disk pack is to be mounted at each specific module address.

Start/Stop Toggle Switches

Each module has a Start/Stop toggle switch that controls application of voltage to the associated module. If a switch is set to the Stop position, the associated module cannot be started from the control unit. Also, placing a Start/Stop switch in the Stop position causes the access mechanism for the affected module to retract from the disk pack and causes power to be removed from the disk drive motor. Disk pack motion then stops in about 15 seconds. If the switch is then placed in the Start position and the module drawer is closed with a disk pack mounted, the disk drive motor turns on and an automatic seek to cylinder 000 is performed. The time for the individual module to become operational is then about 60 seconds.

Select Lock Indicators

This red indicator (separate indicator on each module) lights when an equipment malfunction occurs for the associated module. If this indicator is on, call the IBM Customer Engineer.

Ready Indicator (Labeled A-J)

This is a green indicator with the physical device location (A-J) imprinted on it. This indicator will turn on following completion of the head loading sequence. This indicator turns off during the following times:

1. When a seek operation is being performed - this is a normal condition.
2. When the access mechanism has not detented properly - this is an abnormal condition. In this case, unit check status and seek check (sense byte 0, bit 7) indications are made available to the channel.

Notify the Customer Engineer if the Ready indicator for any otherwise operational module turns off.

OPERATORS GUIDE

Disk Pack Handling

Each IBM 2316 Disk Pack is protected in transit by a special container.

When the disk pack is received, examine the container closely. If its condition is acceptable, remove the disk pack and store it. Keep the container; you may need it later.

If the container or its contents show any unusual shipping damage, do not use the disk pack. Retain the damaged container and disk pack in its "as received" condition and notify an IBM Customer Engineer immediately.

Disk packs have been designed to be easily transported from location to location. For best shipping results:

1. Be sure the pack is secure in its two-piece cover. (Figure 49)
2. Use only the specially designed IBM shipping container. If the original container is worn or damaged, a new carton should be ordered.

Handle a disk pack only with its cover on. If the disk pack is accidentally dropped, or receives a sharp impact of any kind, have it inspected by an IBM Customer Engineer before you use it.

Disk Pack Labeling

For identification purposes, IBM recommended labels can be placed on the disk pack center hub (Figure 49). Labels in this location can be read through the transparent disk cover.

The following procedures should be used when labeling disk packs: The customer and volume identification labels shown in Figure 50 are available for use with the 2316 Disk Pack.

1. Use adhesive-backed labels that can be applied and removed easily.
2. Use a writing implement, such as a pen or felt-tip marker, that does not produce a loose residue. Do not use a lead pencil.
3. Write on the label before it is applied to the disk pack.
4. Place the label only on the center hub, not on the disk pack cover or top disk surface.
5. Use a new label if changes to the label information are necessary. Never erase a label that is on a disk pack. Microscopic eraser particles can damage disk surfaces and read/write heads.

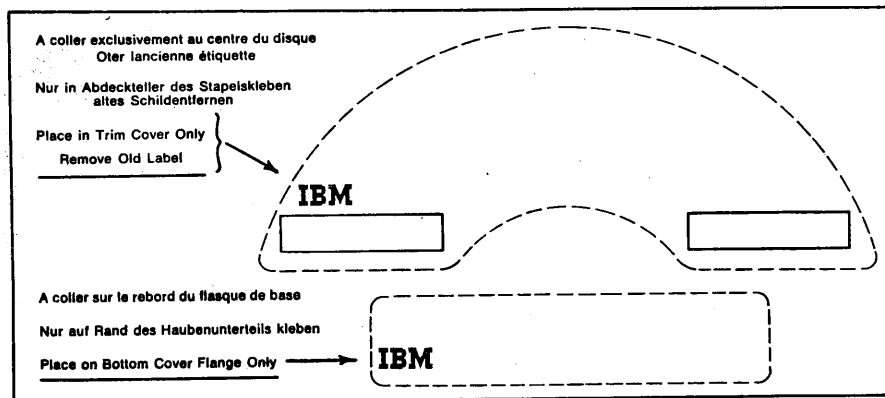


Figure 50. Customer and Volume Identification Labels

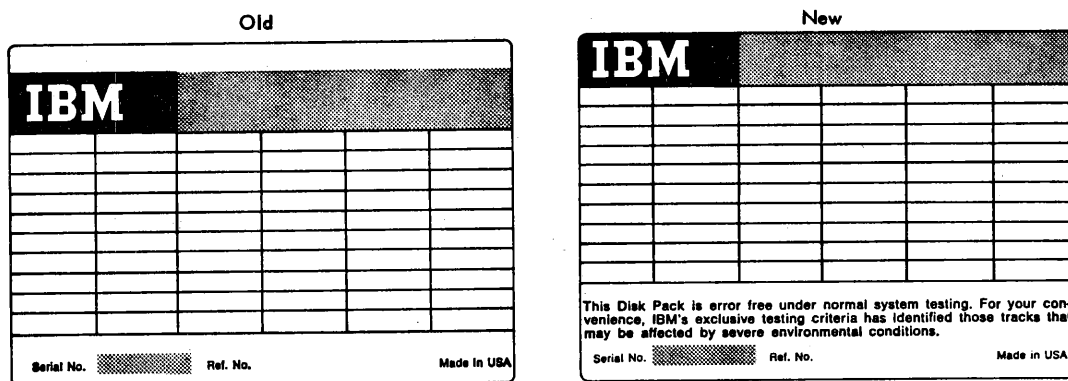


Figure 51. Flagged Track Label

6. Removal or placement of labels can be done only when a disk pack is in place in a file drive module location. Do not attempt to remove the top cover when the disk pack is out of the file drive module.

Disk Pack Cover

A two-piece plastic cover (Figure 49) protects the disk pack from dust and moisture when the disk pack is not in the file drive module. If the cover is damaged, it may lose its protective capability and should be replaced.

On the top section of the plastic cover is a handle that is used for carrying the pack. A self-locking device in the handle permits removal of the disk pack from the file drive module only if the top part of the cover is first locked on the disk pack. The plastic cover should never be left on a disk pack that is mounted in a file drive module location.

The lower half of the plastic cover should be secured to any 2316 that is not mounted in the file drive module.

Disk Pack Storage

To assure maximum disk pack life and reliability:

1. Store the disk packs flat, not on edge.
2. Each pack should rest on a shelf, not on another disk pack.
3. Store in a clean, enclosed metal cabinet or a similar fire-resistant container, never in direct sunlight.
4. Store disk packs in a machine-room atmosphere (60°F to 90°F, 10% to 80% humidity).
5. If a disk pack must be stored in a different environment, allow two hours for adjustment to machine room atmosphere before use.
6. Always be sure that both the top and bottom plastic covers are on a disk pack whenever it is out of a file drive module location.

Error Free Disk Packs

All 2316 disk packs are error free.

The error free disk packs can be recognized by a new flagged track label (Figure 51).

Disk Pack Loading

1. Open the module drawer and remove the mounted disk pack, if any, using the procedure described in Disk Pack Unloading.
2. Remove the bottom cover of the disk pack to be mounted by turning the bottom locking knob.
3. It may be necessary to move (gently) the disk brush assembly out of the way if it extends into the disk pack area (Figure 52).
4. Place the 2316 disk pack with top cover, on the spindle.
5. Turn the top cover in the direction of the arrow until firm resistance is met.
6. Lift the top cover from the disk pack.

Caution

Do not close a module drawer if the top cover is still on the disk pack.

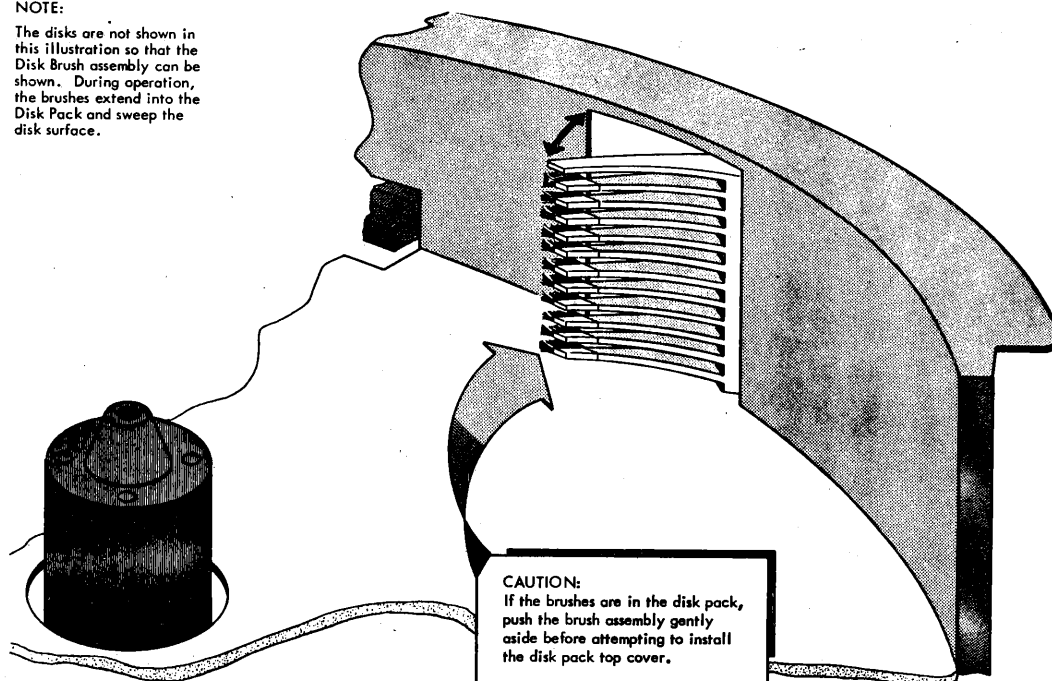
7. Slide the module drawer back into the file drive module. To assure that the drawer has been properly closed after the mounting of a pack, an attempt to open the drawer while maintaining a downward pressure on the handle should be made. If closed, it will not open as it cannot be opened without an upward lift on the handle.
8. Check to make sure that the correct module identifier plug is in the module's receptacle.
9. Place the Start/Stop switch for the module in the Start position to return the module to operation. The module returns to operational status about 60 seconds after the Start/Stop switch is placed in the Start position.

Disk Pack Unloading

1. Place the Start/Stop switch of the affected module in the Stop position. (Note that power is removed from the disk drive motor when the module drawer is opened, even if the Start/Stop switch is in the Start position.)
2. Wait about 15 seconds and then open the module drawer.
3. Be sure that disk pack motion has stopped before you perform any of the following steps.
4. Separate the top and bottom disk pack covers.
5. If the brush assembly extends into the disk pack, gently move it out of the way (Figure 52) and place the disk pack top cover on the disk pack.

NOTE:

The disks are not shown in this illustration so that the Disk Brush assembly can be shown. During operation, the brushes extend into the Disk Pack and sweep the disk surface.



CAUTION:
If the brushes are in the disk pack,
push the brush assembly gently
aside before attempting to install
the disk pack top cover.

Figure 52. Disk Brush Assembly

6. Turn the top cover in the direction of the off arrow at least two full turns.
7. Lift the top cover, now containing the disk pack, from the spindle.
8. Firmly fasten the bottom cover to the disk pack.
9. Be sure that the module drawer is not left open if you do not intend to load a new pack immediately.
10. Store the disk pack in a clean cabinet or on a clean shelf. (See Disk Pack Storage in this manual.)

Changing a Module Address

The address of a file module is normally changed only when a module requires maintenance. To change the address of any module:

1. Make sure that the program(s) controlling the Direct Access Storage Facility is in a Wait State or that the existing condition allows removal of module identifier plug.
2. Remove the module identifier plug from the affected modules and perform any necessary pack changes.
3. Place the module identifier plugs in the appropriate receptacles.
4. Program control is now in effect.

Always ensure that the module plug is completely in or completely out. If the module plug is left part way out for an extended period of time, it may cause damage to the disk drive module.

APPENDIX

ALPHABETIC LIST OF INSTRUCTIONS

NAME	MNEMONIC	FORMAT	EXCEPTIONS	CODE
ADD	AR	RR	C IF	1A
ADD	A	RX	C P A S IF	5A
ADD DECIMAL	AP	SS	C P A S D DF	FA
ADD HALFWORD	AH	RX	C P A S IF	4A
ADD LOGICAL	ALR	RR	C	1E
ADD LOGICAL	AL	RX	C P A S	5E
ADD NORMALIZED LONG	N ADR	RR	C S U E LS	2A
ADD NORMALIZED LONG	N AD	RX	C P A S U E LS	6A
ADD NORMALIZED SHORT	N AER	RR	C S U E LS	3A
ADD NORMALIZED SHORT	N AE	RX	C P A S U E LS	7A
ADD UNNORMALIZED LONG	AWR	RR	C S E LS	2E
ADD UNNORMALIZED LONG	AW	RX	C P A S E LS	6E
ADD UNNORMALIZED SHORT	AUR	RR	C S E LS	3E
ADD UNNORMALIZED SHORT	AU	RX	C P A S E LS	7E
AND	NR	RR	C	14
AND	N	RX	C P A S	54
AND	NI	SI	C P A	94
AND	NC	SS	C P A	D4
BRANCH AND LINK	BALR	RR		05
BRANCH AND LINK	BAL	RX		45
BRANCH ON CONDITION	BCR	RR		07
BRANCH ON CONDITION	BC	RX		47
BRANCH ON COUNT	BCTR	RR		06
BRANCH ON COUNT	BCT	RX		46
BRANCH ON INDEX HIGH	BXH	RX		86
BRANCH ON INDEX LOW OR EQUAL	BXLE	RS		87
COMPARE	CR	RR	C	19
COMPARE	C	RX	C P A S	59
COMPARE DECIMAL	CP	SS	C P A S D	F9
COMPARE HALFWORD	CH	RX	C P A S	49
COMPARE LOGICAL	CLR	RR	C	15
COMPARE LOGICAL	CL	RX	C P A S	55
COMPARE LOGICAL	CLI	SI	C P A	95
COMPARE LOGICAL	CLC	SS	C P A	D5
COMPARE LONG	CDR	RR	C S	29
COMPARE LONG	CD	RX	C P A S	69
COMPARE SHORT	CER	RR	C S	39
COMPARE SHORT	CE	RX	C P A S	79
CONVERT AND SORT SYMBOLS	CSS	RR	C P A S	02
CONVERT TO BINARY	CVB	RX	P A S D IK	4F
CONVERT TO DECIMAL	CVD	RX	P A S	4E

ALPHABETIC LIST OF INSTRUCTIONS (continued)

NAME	MNEMONIC	FORMAT	EXCEPTIONS	CODE
CONVERT WEATHER LINES	CVWL	RR	P A S	03
DELAY	DLY	RR		0B
DIAGNOSE		SI	M P A S	83
DIVIDE	DR	RR	S IK	1D
DIVIDE	D	RX	P A S IK	5D
DIVIDE DECIMAL	DP	SS	P A S D DK	FD
DIVIDE LONG	N DDR	RR	S U E FK	2D
DIVIDE LONG	N DD	RX	P A S U E FK	6D
DIVIDE SHORT	N DER	RR	S U E FK	3D
DIVIDE SHORT	N DE	RX	P A S U E FK	7D
EDIT	ED	SS	C P A D	DE
EDIT AND MARK	EDMK	SS	C P A D	DF
EXCLUSIVE OR	XR	RR	C	17
EXCLUSIVE OR	X	RX	C P A S	57
EXCLUSIVE OR	XI	SI	C P A	97
EXCLUSIVE OR	XC	SS	C P A	D7
EXECUTE	EX	RX	P A S EX	44
HALT I/O	HIO	SI	CM	9E
HALVE LONG	N HDR	RR	S U	24
HALVE SHORT	N HER	RR	S U	34
INSERT ADDRESS TRANSLATOR	IATR	RR		0E
INSERT CHARACTER	IC	RX	P A	43
INSERT STORAGE KEY	ISK	RR	M A S	09
LOAD	LR	RR		18
LOAD	L	RX	P A S	58
LOAD ADDRESS	LA	RX		41
LOAD AND TEST	LTR	RR	C	12
LOAD AND TEST LONG	LTDR	RR	C S	22
LOAD AND TEST SHORT	LTER	RR	C S	32
LOAD CHAIN	LC	RX	C P A S	52
LOAD COMPLEMENT	LCR	RR	C IF	13
LOAD COMPLEMENT LONG	LCDR	RR	C S	23
LOAD COMPLEMENT SHORT	LCER	RR	C S	33
LOAD HALFWORD	LH	RX	P A S	48
LOAD IDENTITY	LI	RR		0C
LOAD LONG	LDR	RR	S	28
LOAD LONG	LD	RX	P A S	68
LOAD MULTIPLE	LM	RS	P A S	98
LOAD NEGATIVE	LNR	RR	C	11
LOAD NEGATIVE LONG	LNDR	RR	C S	21
LOAD NEGATIVE SHORT	LNER	RR	C S	31
LOAD POSITIVE	LPR	RR	C IF	10
LOAD POSITIVE LONG	LPDR	RR	C S	20
LOAD POSITIVE SHORT	LPER	RR	C S	30
LOAD PS BASE ADDRESS	LPSB	SI	M P A S	A1
LOAD PSW	LPSW	SI	LM P A S	82

ALPHABETIC LIST OF INSTRUCTIONS (continued)

NAME	MNEMONIC	FORMAT	EXCEPTIONS	CODE
LOAD SHORT	LER	RR	S	38
LOAD SHORT	LE	RX	P A S	78
MOVE	MVI	SI	P A	92
MOVE	MVC	SS	P A	D2
MOVE NUMERICS	MVN	SS	P A	D1
MOVE WITH OFFSET	MVO	SS	P A	F1
MOVE WORD	MVW	SS	P A S	D8
MOVE ZONES	MVZ	SS	P A	D3
MULTIPLY	MR	RR	S	1C
MULTIPLY	M	RX	P A S	5C
MULTIPLY DECIMAL	MP	SS	P A S D	FC
MULTIPLY HALFWORD	MH	RX	P A S	4C
MULTIPLY LONG	N MDR	RR	S U E	2C
MULTIPLY LONG	N MD	RX	P A S U E	6C
MULTIPLY SHORT	N MER	RR	S U E	3C
MULTIPLY SHORT	N ME	RX	P A S U E	7C
OR	OR	RR	C	16
OR	O	RX	C P A S	56
OR	OI	SI	C P A	96
OR	OC	SS	C P A	D6
PACK	PACK	SS	P A	F2
READ DIRECT	RDD	SI	M P A S	85
REPACK SYMBOLS	RPSB	RR	C P A S	OF
SET ADDRESS TRANSLATOR	SATR	RR	CM S	0D
SET CONFIGURATION	SCON	RR	CM S	01
SET PCI	SPCI	SI	CM	9B
SET PROGRAM MASK	SPM	RR	L	04
SET STORAGE KEY	SSK	RR	M A S	08
SET SYSTEM MASK	SSM	SI	M P A	80
SHIFT LEFT DOUBLE	SLDA	RS	C S IF	8F
SHIFT LEFT DOUBLE LOGICAL	SLDL	RS	S	8D
SHIFT LEFT SINGLE	SLA	RS	C IF	8B
SHIFT LEFT SINGLE LOGICAL	SLL	RS		89
SHIFT RIGHT DOUBLE	SRDA	RS	C S	8E
SHIFT RIGHT DOUBLE LOGICAL	SRDL	RS	S	8C
SHIFT RIGHT SINGLE	SRA	RS	C	8A
SHIFT RIGHT SINGLE LOGICAL	SRL	RS		88
START I/O	SIO	SI	CM	9C
START I/O PROCESSOR	SIOP	SI	CM S	9A
STORE	ST	RX	P A S	50
STORE CHARACTER	STC	RX	P A	42
STORE HALFWORD	STH	RX	P A S	40
STORE LONG	STD	RX	P A S	60
STORE MULTIPLE	STM	RS	P A S	90

ALPHABETIC LIST OF INSTRUCTIONS (continued)

NAME	MNEMONIC	FORMAT	EXCEPTIONS	CODE
STORE PS BASE ADDRESS	SPSB	SI	M P A S	A0
STORE SHORT	STE	RX	P A S	70
SUBTRACT	SR	RR	C IF	1B
SUBTRACT	S	RX	C P A S IF	5B
SUBTRACT DECIMAL	SP	SS	C P A D DF	FB
SUBTRACT HALFWORD	SH	RX	C P A S IF	4B
SUBTRACT LOGICAL	SLR	RR	C	1F
SUBTRACT LOGICAL	SL	RX	C P A S	5F
SUBTRACT NORMALIZED LONG	N SDR	RR	C S U E LS	2B
SUBTRACT NORMALIZED LONG	N SD	RX	C P A S U E LS	6B
SUBTRACT NORMALIZED SHORT	N SER	RR	C S U E LS	3B
SUBTRACT NORMALIZED SHORT	N SE	RX	C P A S U E LS	7B
SUBTRACT UNNORMALIZED LONG	SWR	RR	C S E LS	2F
SUBTRACT UNNORMALIZED LONG	SW	RX	C P A S E LS	6F
SUBTRACT UNNORMALIZED SHORT	SUR	RR	C S E LS	3F
SUBTRACT UNNORMALIZED SHORT	SU	RX	C P A S E LS	7F
SUPERVISOR CALL	SVC	RR		0A
TEST AND SET	TS	SI	C P A	93
TEST CHANNEL	TCH	SI	CM	9F
TEST I/O	TIO	SI	CM	9D
TEST UNDER MASK	TM	SI	C P A	91
TRANSLATE	TR	SS	P A	DC
TRANSLATE AND TEST	TRT	SS	C P A	DD
UNPACK	UNPK	SS	P A	F3
WRITE DIRECT	WRD	SI	CM P A S	84
ZERO AND ADD	ZAP	SS	C P A D DF	F8

Legend

A Addressing exception
 C Condition code is set
 D Data exception
 DF Decimal-overflow exception
 DK Decimal-divide exception
 E Exponent-overflow exception
 EX Execute exception
 FK Floating-point divide exception
 IF Fixed-point overflow exception
 IK Fixed-point divide exception
 L New condition code loaded
 LS Significance exception

Legend - (continued)

M	Privileged-operation exception
N	Normalized operation
P	Protection exception
S	Specification exception
U	Exponent-underflow exception